III. RECOVERY STRATEGIES

A. RECOVERY GOALS, OBJECTIVES, AND CRITERIA

1. Recovery Goals and Objectives

The ultimate goal of this draft recovery plan is to recover all listed species so they can be delisted (removed from listing under the Endangered Species Act). The interim goal is to recover all endangered species to the point that they can be downlisted from endangered to threatened status. The goal for *Cordylanthus maritimus* ssp. *maritimus* (salt marsh bird's beak) is to support recovery strategies detailed in the Salt Marsh Bird's Beak Recovery Plan (U.S. Fish and Wildlife Service 1985*a*). For species covered by this draft recovery plan that are not federally listed as threatened or endangered, the goal is to conserve them so as to avoid the need for protection provided by listing.

To achieve these goals, the following objectives have been developed:

1. Secure self-sustaining wild *populations* of each covered species throughout their full ecological, geographical, and *genetic* range.

2. Ameliorate or eliminate, to the extent possible, the threats that caused the species to be listed or of concern and any future threats.

3. Restore and conserve a healthy ecosystem function supportive of *tidal marsh* species.

If these objectives are met for the covered species, the recovery and conservation goals will be reached.

2. Recovery Units

For most species covered in this draft recovery plan, *recovery units* have been designated. A recovery unit is a special unit of a listed species' range that is geographically or otherwise identifiable and is important to the recovery of the listed species. Recovery units are individually important to conservation of unique *biotic* and abiotic factors (such as *genetic* robustness, *demographic* robustness, important life history stages, or other features) necessary for the long-term sustainability of species within the recovery unit. Although recovery units are not designated for non-listed species, the establishment of recovery units for the listed species will assist in meeting the conservation objectives for the non-listed species in this draft recovery plan as well.

Recovery units are not listed as separate entities and cannot be delisted individually. Each recovery unit designated for a species must be recovered before a species can be delisted (**Table III-1** lists the recovery units designated for each species). Recovery of each listed species discussed in this draft recovery plan depends upon satisfying the recovery criteria within each recovery unit for the given species. Recovery units do not represent distinct *population* segments nor do they reflect designated critical habitat for any of the species covered in this draft

recovery plan. The respective status of each species in each recovery unit varies, as does their potential to contribute to each species' recovery.

Table III-1 Recovery Units Included in this Draft Recovery Plan and Listed Species Known to Occupy each Recovery Unit

Listed Species	Recovery Unit				
	Suisun Bay Area	San Pablo Bay	Central/South San Francisco Bay	Central Coast	Morro Bay
Cirsium hydrophilum var. hydrophilum (Suisun thistle)	X				
Cordylanthus mollis ssp. *mollis* (soft bird's beak)	X	X			
Suaeda californica (California seablite)			X		X
California clapper rail (*Rallus longirostris obsoletus*)	X	X	X	X	
Salt marsh harvest mouse (*Reithrodontomys raviventris*)	X	X	X		

Maintaining representation of each species throughout their respective ranges is necessary for the long-term recovery and conservation of the listed species covered in this draft recovery plan. Protecting *populations* distributed throughout a species range conserves the natural range of morphological, physiological, *genetic* and environmental variation of the species. This helps ameliorate the vulnerability of a species to environmental fluctuations and *catastrophe*s as well as protects evolutionary potential. To ensure that each *taxon* in this draft recovery plan can persist despite weather variations, climate change, or *catastrophic* events, the suite of *populations* in recovery areas should represent the full range of environmental conditions in which the *taxon* occurred historically. The range of *genetic* variation must be represented to allow for evolution and response to environmental change. *Genetic* diversity has not been investigated for most taxa covered in this draft recovery plan; therefore, well-distributed *populations* across the species' range and across ecological conditions are recommended as a surrogate for preserving *genetic* diversity.

The recovery units established in this draft recovery plan were based upon the natural division of the plan area into discrete sub-areas, which also correspond to ecologically distinct zones or areas somewhat isolated from each other biologically. Many of the species share the same recovery units. **Figure III-1** gives an overview of *tidal marsh* ecosystem recovery units. **Figures III-2** through **III-6** depict the five individual recovery units, with map segments and criteria-based regional planning units (*marsh* complexes) identified.

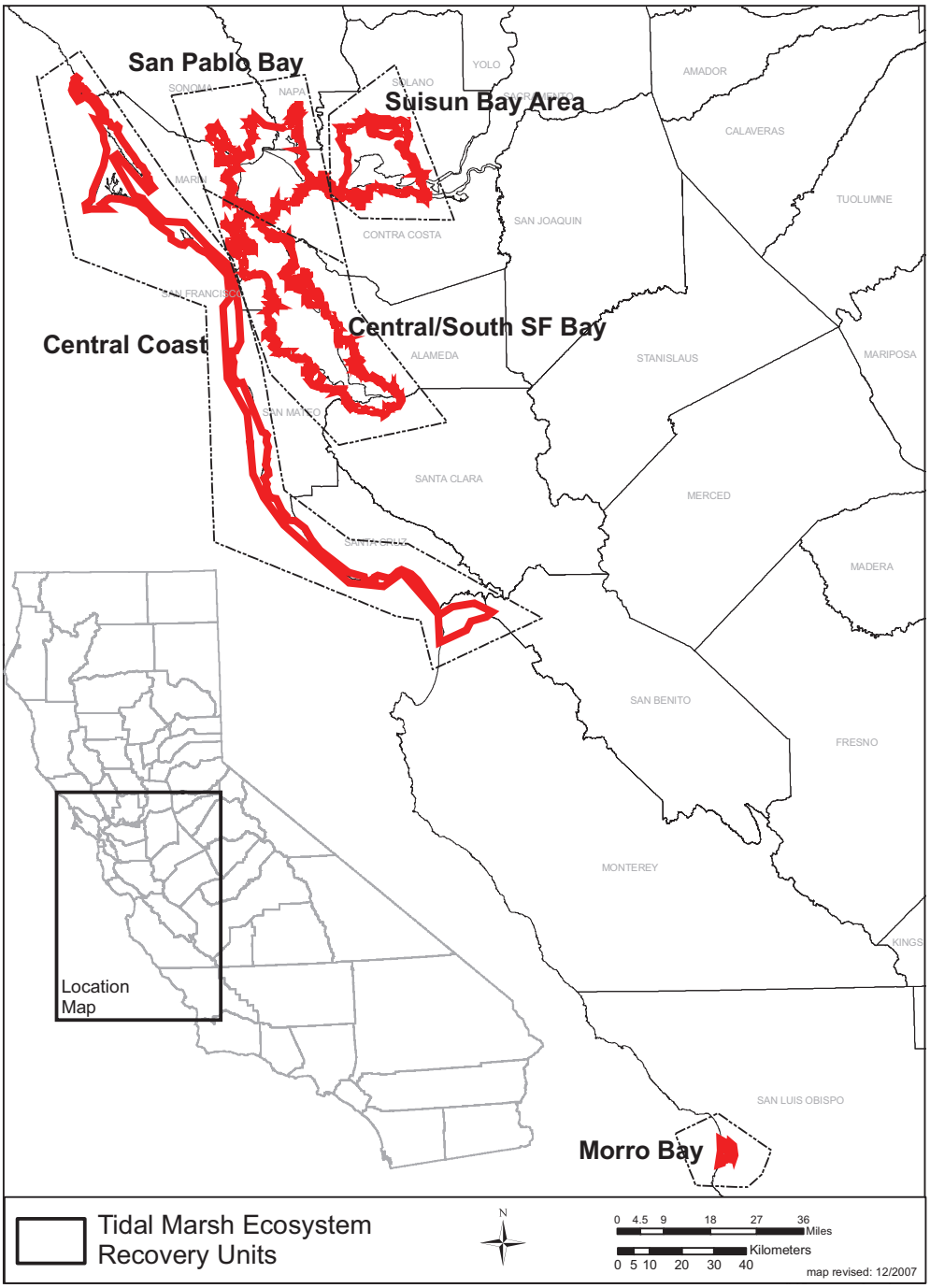

Figure III-1. Overview of Tidal Marsh Ecosystem Recovery Units

Figure III-1. Overview of tidal marsh ecosystem recovery units.

Each recovery unit described below is necessary because each (1) protects one of more *populations* of the covered species found in it, (2) contributes to protection of *populations* throughout the geographic ranges of the covered species found in it, and (3) protects geographically distinct *populations* and thereby the natural range of morphological, physiological, environmental and/or *genetic* variation.

SUISUN BAY AREA RECOVERY UNIT

The Suisun Bay Area recovery unit (**Figure III-2**) includes suitable or restorable tideland habitats in the Suisun Bay area from Carquinez Strait to the edge of the Delta (legal Delta boundary), representing the eastern extent of the range of the covered species. It is separated from the San Pablo Bay recovery unit by gaps in habitat in the Carquinez Strait and intervening hills. Limited *populations* of *Cirsium hydrolphilum* ssp. *hydrophilum, Cordylanthus mollis* ssp. *mollis* and salt marsh harvest mouse exist within the Suisun Bay area recovery unit. *Populations* of California clapper rail in this recovery unit are sparser and more tenuous than in other recovery units, but are expected to strengthen with habitat restoration and rising sea level. In addition to being necessary for the reasons described above, this unit is necessary because it provides a suitable pathway for the species' habitat to shift up the *estuary* as anticipated climate change and sea level rise produce increasing salinities toward the east.

SAN PABLO BAY RECOVERY UNIT

The San Pablo Bay recovery unit (**Figure III-3**) encompasses San Pablo Bay *populations* and is separated from adjacent recovery units by gaps in *populations* and habitat for most covered species. The unit includes tideland habitats from Point San Pablo on the Contra Costa coast and Point San Pedro, Marin County, to the Carquinez Strait at the Carquinez (I-80) Bridge. *Population* dynamics of covered species in this unit are likely decoupled from adjacent units because of low dispersal relative to local recruitment. Limited *populations* of *Cordylanthus mollis* ssp. *mollis,* California clapper rail, and salt *marsh* harvest mouse exist within the San Pablo Bay recovery unit. This recovery unit is less altered by development at higher elevations than the Central/South San Francisco Bay recovery unit, so accommodation of rising sea level can be more readily achieved here, and accompanying increased *salinity* may enhance habitat conditions for the covered species. Although the Carquinez Strait presents a natural barrier to habitat connectivity between the San Pablo Bay and Suisun Bay Area recovery units, there may exist some degree of habitat and *population* connectivity between the San Pablo Bay and Central/South San Francisco Bay recovery units.

CENTRAL/SOUTH SAN FRANCISCO BAY RECOVERY UNIT

The Central/South San Francisco Bay recovery unit (**Figure III-4**) encompasses suitable or restorable tidelands from Point San Pablo on the Contra Costa coast and Point San Pedro, Marin County, to the extreme southern extent of the Bay. Limited *populations* of *Suaeda californica* and salt marsh harvest mouse exist within the Central/South San Francisco Bay recovery unit. This recovery unit supports the majority of California clapper rail *populations*. *Populations* in this unit are widely separated from northern ones, but there may be occasional dispersal between the areas. Covered species in this recovery unit face unique management issues that vary

substantially from other recovery units (*i.e.*, *invasive Spartina* control, current planning and implementation of extensive *tidal marsh* restoration, and high human density and recreational pressure).

CENTRAL COAST RECOVERY UNIT

Habitats of the Central Coast recovery unit (**Figure III-5**) possess California's distinct maritime climate (cool with little temperature variation), as opposed to the more continentally influenced climates in the San Francisco Bay Estuary. This unit includes suitable or restorable tidelands along the California coast from Bodega Head south to the mouth of the Salinas River. The California clapper rail is the only listed species covered in this draft recovery plan that occurs in the Central Coast recovery unit. The Central Coast recovery unit includes the southern range of the California clapper rail to Elkhorn Slough, and its *population* in Tomales Bay, Marin County. Isolated from the San Francisco Bay California clapper rails by wide gaps in habitat, *population* dynamics of the California clapper rails in the Central Coast recovery unit may be *demographically* distinct. The Central Coast recovery unit is necessary for recovery of this species in the coastal portion of its range, which will also provide additional protection for the species in an unpredictable ecosystem. This recovery unit also is needed to provide habitat diversity and capacity for habitat shifts and to hedge against progressive adverse environmental or ecological impacts in other parts of the range, such as *non-native* species invasions or climate alteration due to changes in atmospheric or ocean conditions (*e.g.*, climate warming or "El Niño"-like conditions).

MORRO BAY RECOVERY UNIT

The Morro Bay recovery unit (**Figure III-6**) encompasses suitable or restorable tidelands within Morro Bay, including extensive *tidal mudflats*, sandflats, *tidal marsh* plains, and *brackish marsh ecotones*, patterned over the convergent deltas and distributary channels of the Chorro Creek and Los Osos Creek drainages. The recovery unit also includes a large barrier spit and dune system. Until the early 2000s, the Morro Bay recovery unit supported the only remaining natural *population* of *Suaeda californica*. *Suaeda californica* in this recovery unit faces management issues primarily related to recreational use.

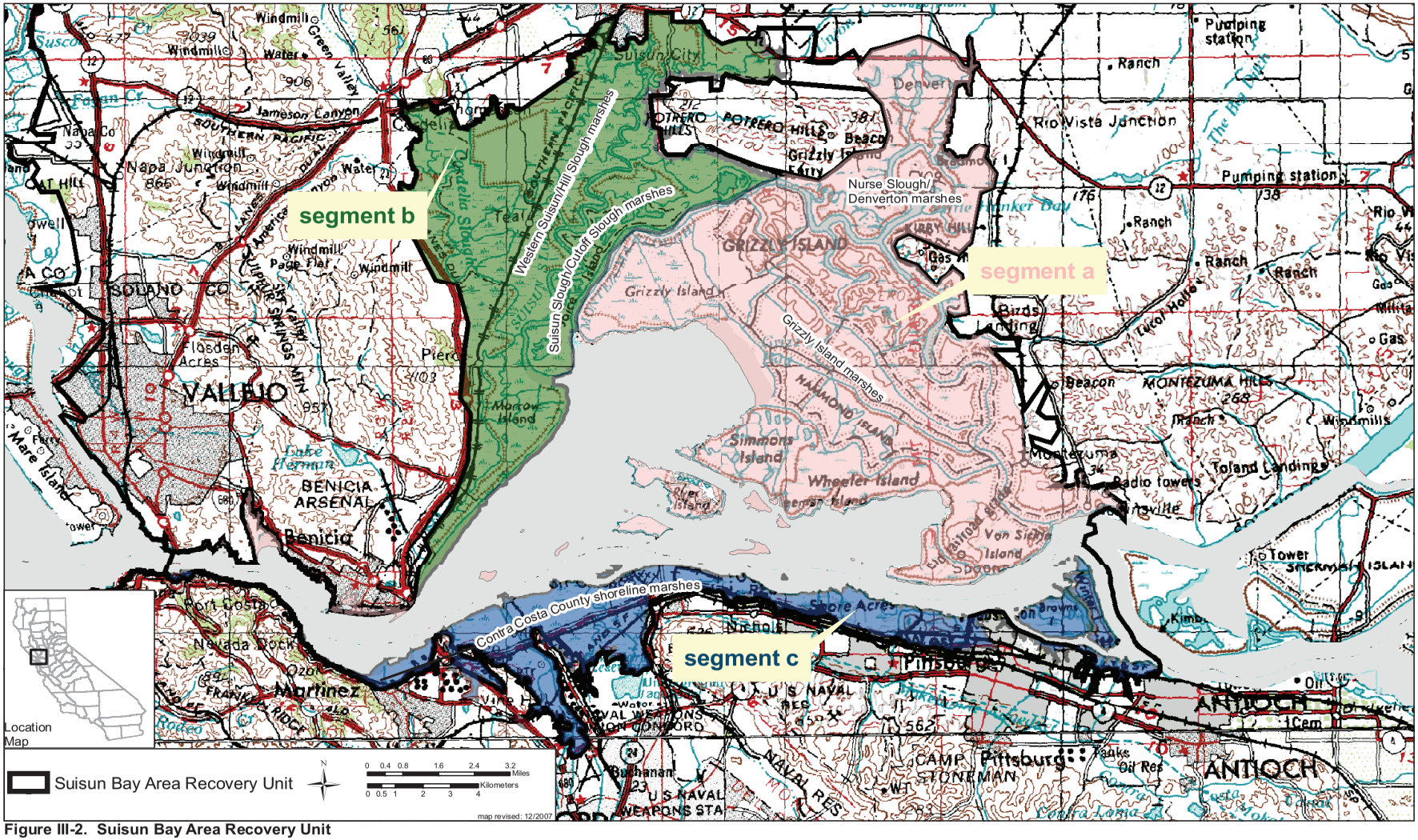

Figure III-2. Suisun Bay Area Recovery Unit

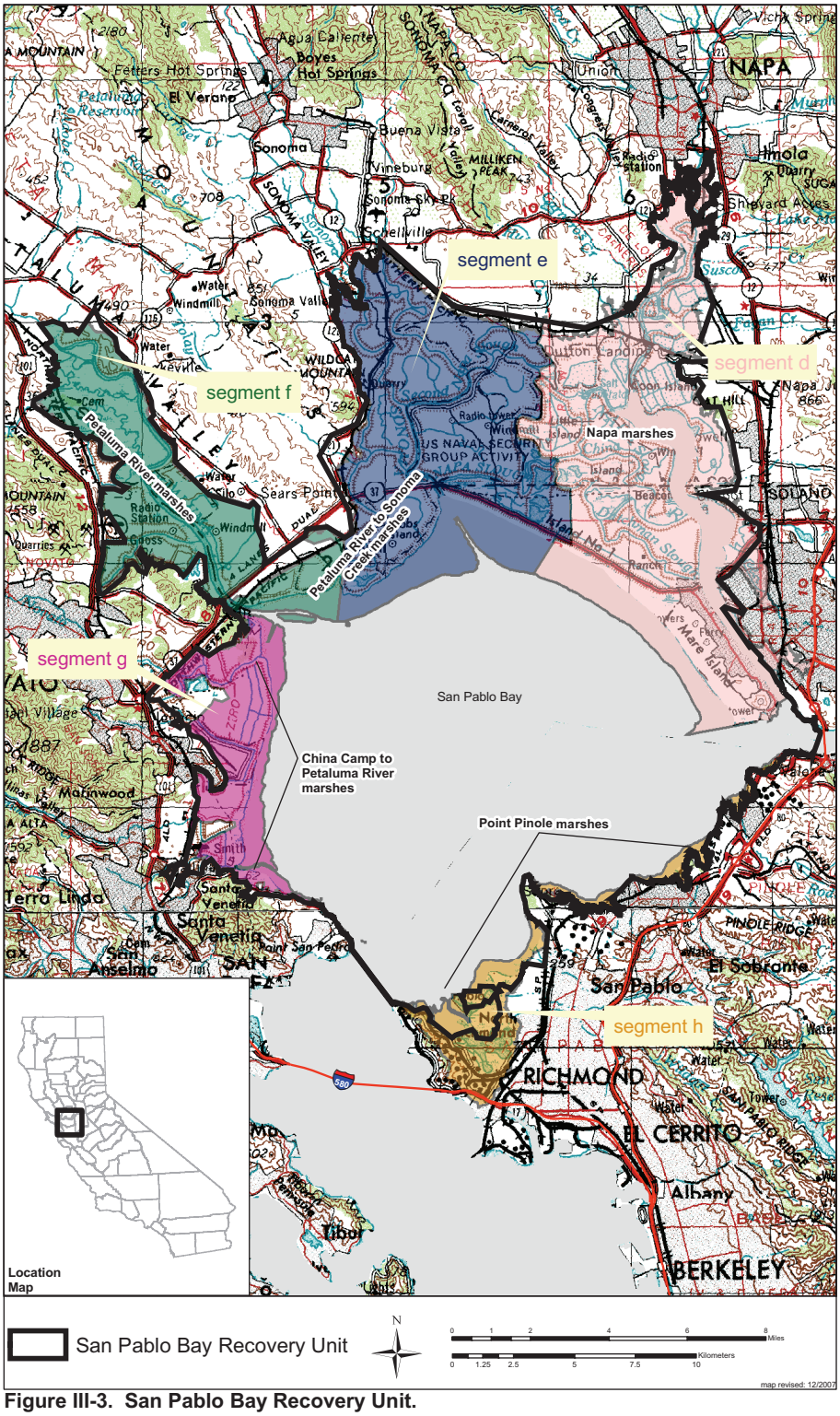

Figure III-3. San Pablo Bay Recovery Unit.

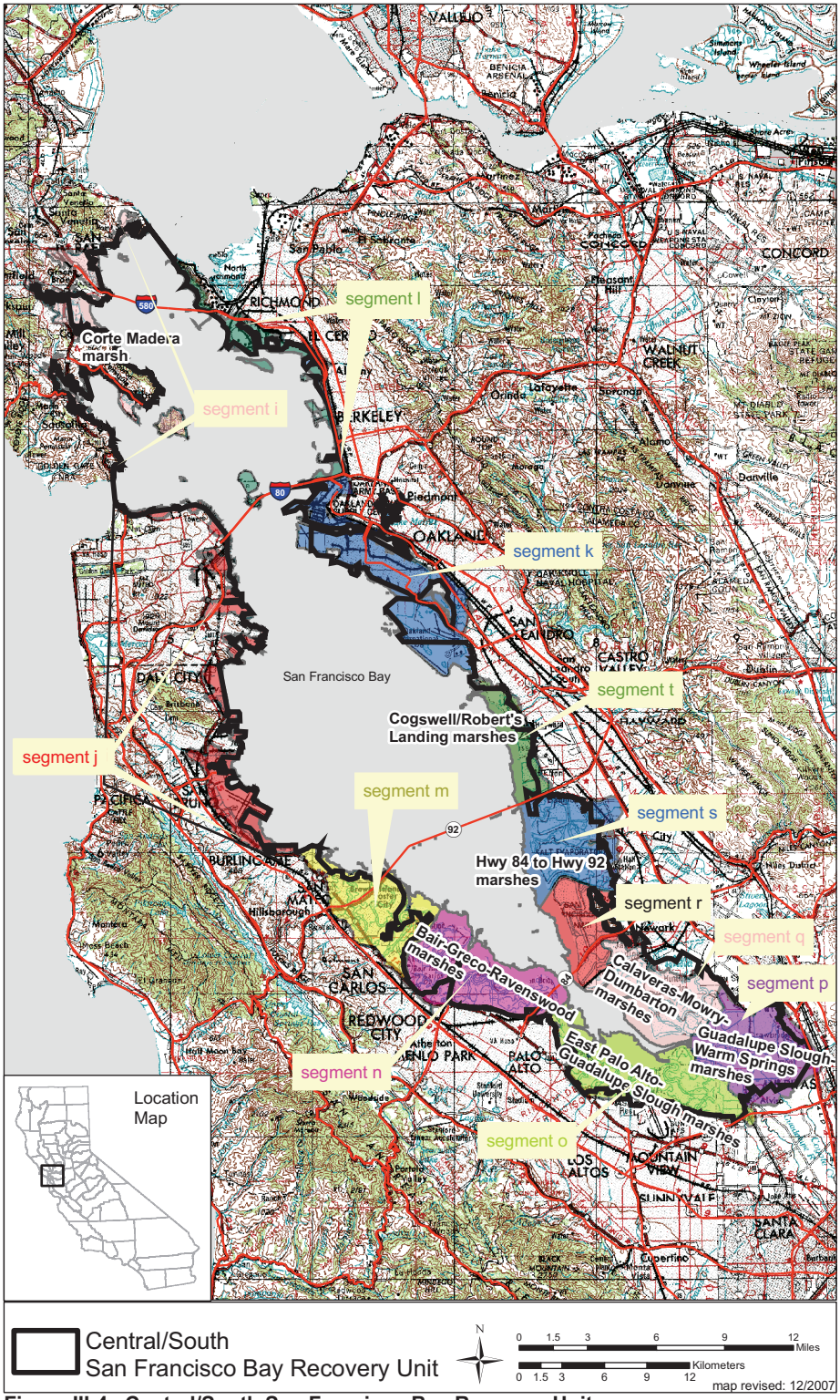

Figure III-4. Central/South San Francisco Bay Recovery Unit.

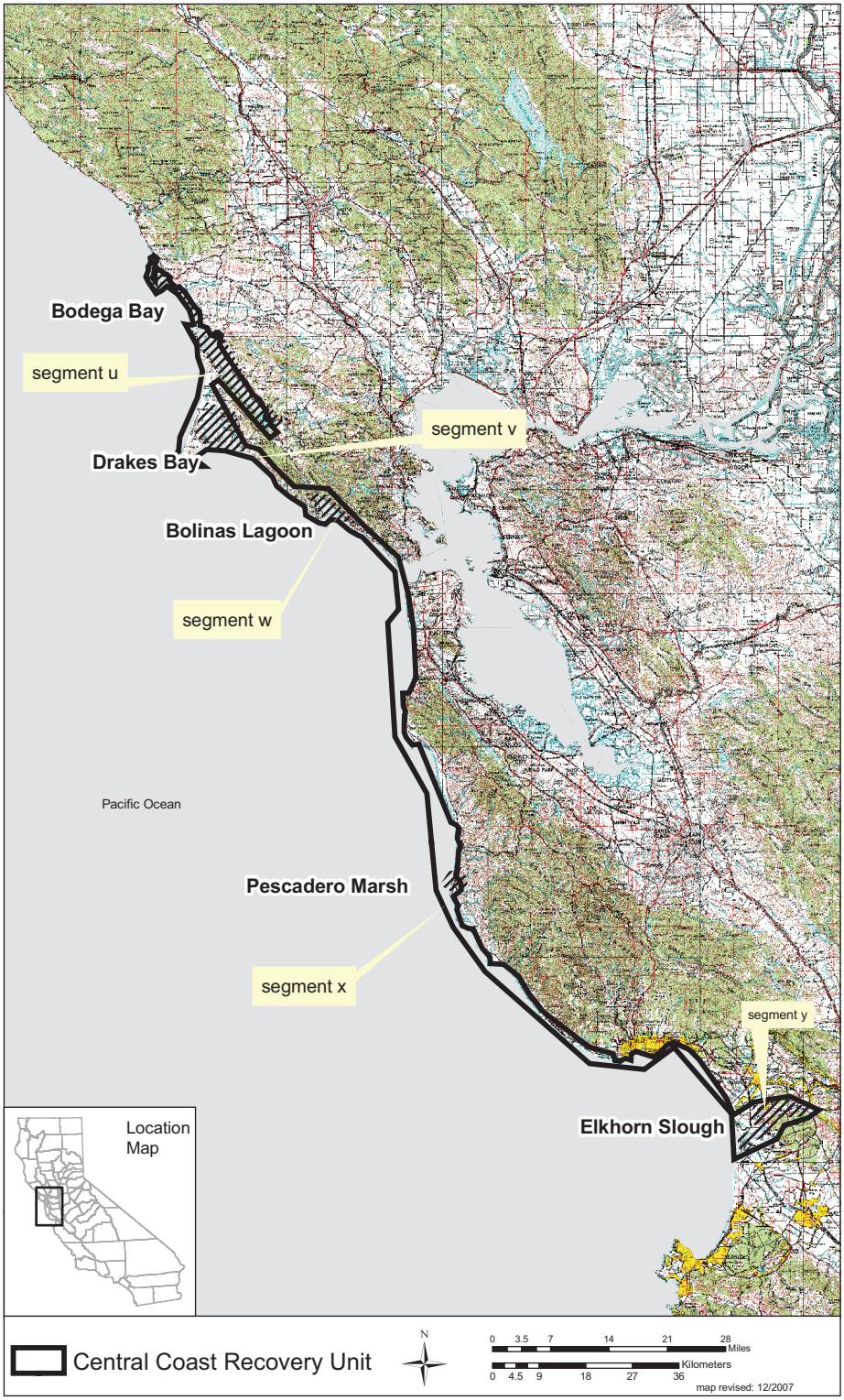

Figure III-5. Central Coast Recovery Unit.

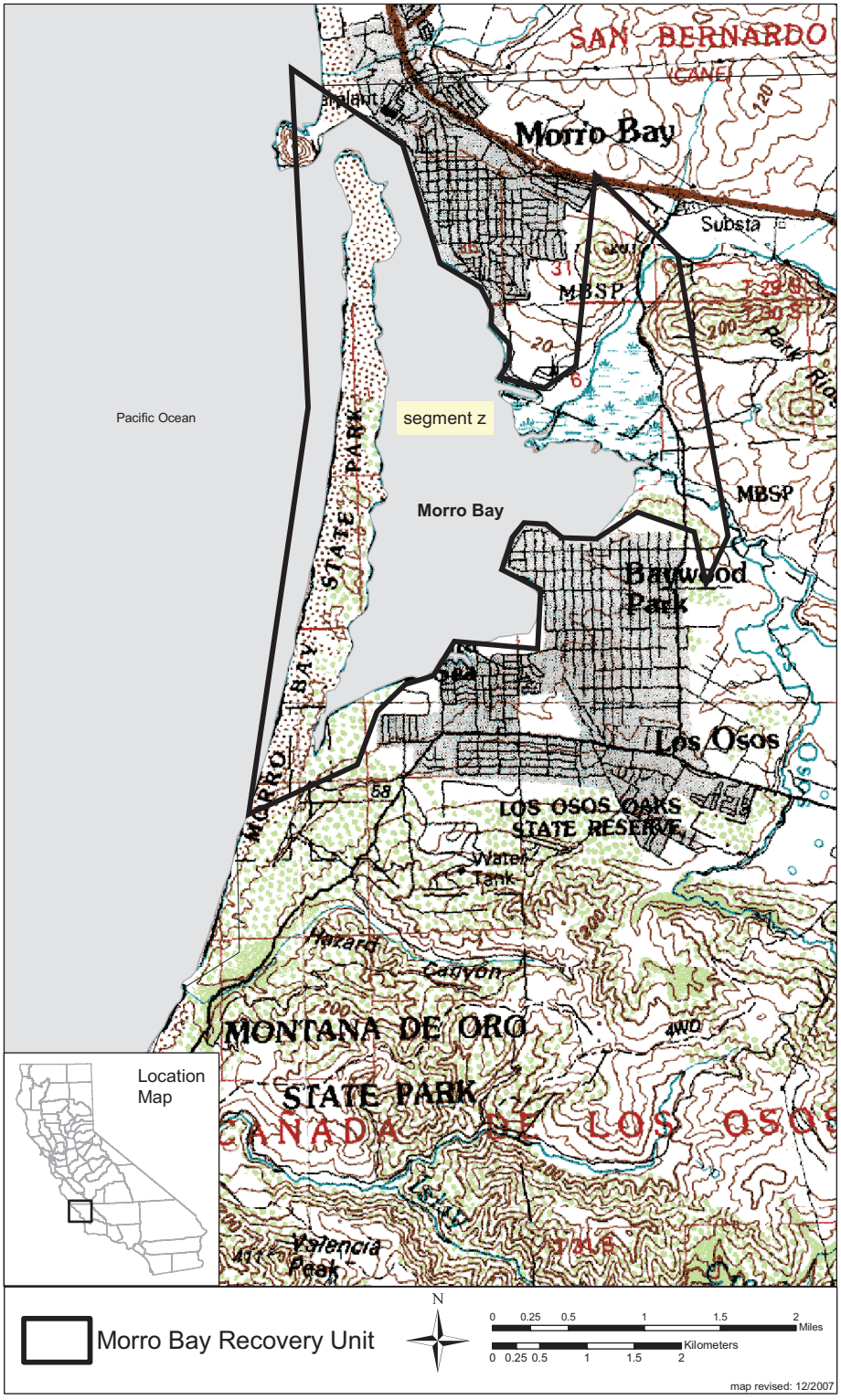

Figure III-6. Morro Bay Recovery Unit.

3. Recovery Criteria

An endangered species is defined in the Endangered Species Act as a species that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. When we evaluate whether or not a species warrants downlisting or delisting, we consider whether the species meets either of these definitions. A recovered species is one that no longer meets the Act's definitions of threatened and endangered. Determining whether a species should be downlisted or delisted requires consideration of the of the same five categories of threats (*i.e.*, the five threat factors, A-E) which were considered when the species was listed and which are specified in section 4(a)(1) of the Endangered Species Act.

Recovery criteria are conditions that, when met, are likely to indicate that a species may warrant downlisting or delisting. Thus, recovery criteria are mileposts that measure progress toward recovery . Recovery criteria are provided below for each listed species covered in this draft recovery plan. Because the appropriateness of downlisting or delisting is assessed by evaluating the five threat factors identified in the Endangered Species Act, the recovery criteria below pertain to and are organized by these factors. These recovery criteria are our best assessment at this time of what needs to be completed so that the species may be downlisted or delisted (*i.e.*, meeting the definition of threatened but not the definition of endangered or meeting neither the definition of threatened nor the definition of endangered, respectively). Because we cannot envision the exact course that recovery may take and because our understanding of the vulnerability of a species to threats is very likely to change as more is learned about the species (*e.g.* habitat, *demography*, *genetics*) and its threats, it is possible that a status review may indicate that downlisting or delisting is warranted although not all recovery criteria are met. Conversely, it is possible that the recovery criteria could be met and a status review may indicate that downlisting or delisting is not warranted (*e.g.* a new threat may emerge that is not addressed by the recovery criteria below and that causes the species to remain threatened or endangered).

Recovery criteria do not apply to non-listed species. For the species of concern covered under this draft recovery plan, we assume that conservation efforts will be a success if *viable*, self-sustaining wild *populations* of these species are conserved in perpetuity and they do not need to be listed under the Endangered Species Act.

Table III-2 summarizes recovery criteria for the covered listed plant species. **Table III-3** summarizes recovery criteria for the California clapper rail and salt marsh harvest mouse.

a. *Cirsium hydrophilum* var. *hydrophilum*

Downlisting Criteria- Cirsium hydrophilum var. *hydrophilum*

Factor A: The present destruction, modification or curtailment of its habitat or range. To reclassify *Cirsium hydrophilum* var. *hydrophilum* to threatened status, threats to the species habitat must be reduced. This will have been accomplished if the following have occurred:

A/1. *Area inhabited:* The median area inhabited by the species must be **2,000 acres** or more over a period of **five** years. The area inhabited by the species shall be the sum of land areas of convex polygons enclosing individuals of each distinct *population*. If there are fewer than three distinct *populations*, this area criterion may be met by a sum of land area(s) **3,000 acres** or more in median value over a period of **five** years.

A/2. *Area preserved* – A total of **4,000 acres** or more must be permanently preserved and under protective management. This must include existing or successfully restored *tidal marsh* areas with suitable habitat for the species and encompass at least 80 percent of the species.

A/3. Reduction in extant *Lepidium latifolium populations* to less than ten percent cover in Suisun Marsh.

A/4. Natural *tidal* cycles[2] must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic *tidal* flooding.

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization currently is not known to be a factor for this species. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to present a major threat at this time. Though seed predation threatens *Cirsium hydrophilum* var. *hydrophilum*, we do not believe amelioration of this threat is required to downlist the species ; therefore, though delisting criteria have been developed, downlisting criteria have not.

Factor D: Inadequacy of existing regulatory mechanisms. . We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To reclassify *Cirsium hydrophilum* var. *hydrophilum* to threatened status, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, *downlisting* criteria under criteria A/1 and A/2 have been met and have resulted in at least the following:

Number of populations:
There may be a minimum of three distinct *populations* or one large *population* within Suisun Marsh. Required target number of individuals is dependant on whether distinct *populations* are easily identifiable, as described below. A distinct *population* shall be any

[2] Tidal cycles approximating those measured at Rush Ranch's First and Second Mallard Branches, Suisun Slough and Cutoff Slough.

concentration of plants with closest individuals to other *populations* greater than 1 kilometer (0.6 mile) apart over a period of five years.

Number of plants:
Median – Over five years of monitoring, there must be a median number of at least 3,000 individuals in the entire species. The third-largest distinct *population* over the same period must have a median number of at least 300 individuals. If there are fewer than three distinct *populations*, the median *population* must be at least 5,000 individuals in the entire speciesover a period of five years.

Minimum – The entire species must not fall below 800 individuals for two consecutive years over a period of five years.

Delisting criteria- Cirsium hydrophilum var. *hydrophilum*

Factor A: The present destruction, modification or curtailment of its habitat or range. To delist *Cirsium hydrophilum* var. *hydrophilum*, threats to the species habitat must be reduced or removed. This will have been accomplished if the following have occurred:

A/1. *Inhabited* – The median area inhabited by the species must be **3,000 acres** or more over a period of **eight years**. The area inhabited by the species shall be the sum of land areas of convex polygons enclosing individuals of each distinct *population*. If not divisible into distinct *populations*, this area criterion may be met by a sum of land area(s) **4,000 acres** or more in median value over a period of **eight years**.

A/2. *Preserved* – A total of **6,000 acres** or more of suitable habitat must be permanently preserved and under protective management. This must include existing or successfully restored *tidal marsh* areas with suitable habitat for the species and encompass at least 80 percent of the species, as well as habitat supporting adequate self-sustaining *populations* of pollinators.

A/3. All *downlisting* criteria under A/3 have been achieved. In addition, a plan must be developed and implemented for early detection and control of *Lepidium latifolium* following any future increase beyond ten percent cover. Also, a funding source must be secured to fund such actions in perpetuity.

A/4. All *downlisting* criteria under A/4 must have been achieved.

A/5. Reliable propagation and *reintroduction* methods must be developed and available.

A/6. Trampling and rooting damage to *Cirsium hydrophilum* var. *hydrophilum* by feral hogs must be eliminated at all *populations*.

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization currently is not known to be a factor for this species. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to present a major threat to *Cirsium hydrophilum* var. *hydrophilum* at this time. However, to delist *Cirsium hydrophilum* var. *hydrophilum*, seed predation pressures need to be reduced or removed. This will have been accomplished if the following has occurred:

C/1. Unnatural seed predator pressures on *Cirsium hydrophilum* var. *hydrophilum* from thistle weevil (*Rhinocyllus conicus*) must fall below a level at which it negatively affects long-term *population* persistence. This level will be determined through future research.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To delist *Cirsium hydrophilum* var. *hydrophilum*, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, *delisting* criteria under criteria A/1 and A/2 have been met and have resulted in at least the following:

Number of populations:
A minimum of **four** distinct *populations* must exist within Suisun Marsh. If the species' *population* is large and not divisible into distinct *populations*, see *Number of plants,* below.

Number of plants:
Median – Over **eight** years of monitoring, there must be a median number of at least **4,000** individuals, spread across at least **four** *populations* and the fourth-largest distinct *population* over the same period must have a median number of at least **500** individuals. If not divisible into distinct *populations*, the median *population* must be at least **7,000** individuals in the entire speciesover a period of **eight** years.

Minimum – The entire speciesmust not fall below **1,000** individuals for two consecutive years over a period of **eight** years.

E/2. *Seed banking* of all existing *populations* and representative *genetic* diversity (per commonly accepted *seed banking* protocols) must be complete.

E/3. Research must be conducted to determine if hybridization is occurring between *Cirsium hydrophilum* var. *hydrophilum* and *Cirsium vulgare*. If research shows that hybridization is occurring, extant *Cirsium vulgare populations* must be eliminated in Suisun Marsh and a monitoring plan must be in place to detect and eliminate future infestations of *Cirsium vulgare.*

E/4. To minimize impacts sustained after oil spills occurring at or near core *populations*, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of *Cirsium hydrophilum* var. *hydrophilum*.

E/5. High *marsh*/upland transition lands, when and wherever possible, must be preserved or created as part of new *marsh* restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. In addition, there must be a partnership developed, involving resource agencies, public landowners/managers and private landowners, to implement Strategic Habitat Conservation (SHC), specifically to guide future habitat acquisition and management goals given the challenge of local sea level rise.

b. *Cordylanthus mollis* ssp. *mollis*

Downlisting criteria- Cordylanthus mollis ssp. *mollis*

Factor A: The present destruction, modification or curtailment of its habitat or range. To reclassify *Cordylanthus mollis* ssp. *mollis* to threatened status, threats to the species habitat must be reduced. This will have been accomplished if the following have occurred:

A/1. *Area inhabited:* Over a five year period, the median area inhabited by the species in the Suisun Bay Area must be **3,000 acres** or more and the area inhabited by the species around San Pablo Bay must be **1,000 acres** or more. The area inhabited by the species shall be the sum of land areas of convex polygons enclosing individuals of each distinct *population*.

A/2. *Area preserved* – A total of **5,000 acres** or more in the Suisun Bay Area and San Pablo Bay area must be permanently preserved and under protective management. This must include existing or successfully restored *tidal marsh* areas with suitable habitat for the species and encompass at least 80 percent of the species.

A/3. Reduction in extant *Lepidium latifolium populations* to less than ten percent cover.

A/4. There must be less than 10% percent total cover of other *non-native*, *invasive perennial* or *non-native* winter *annual* grass species, including *Apium graveolens*

(celery), *Cotula coronipfolia* (brass-buttons), *Juncus gerardi* (black-grass rush), *Spartina patens* (salt-meadow cordgrass), *Polypogon monspeliensis* (annual beard grass), *Hainardia cylindrical* (barbgrass), *Parapholis incurva* (sicklegrass), *Crypsis schoenoides* (swamp grass), and *Lepidium latifolium* within 50 feet of extant *Cordylanthus mollis* ssp. *mollis populations*.

A/5. Natural *tidal* cycles must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic *tidal* flooding.

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization currently is not known to be a factor for this species. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to present a major threat to *Cordylanthus mollis* ssp. *mollis* at this time. Though seed predation threatens *Cordylanthus mollis* ssp. *mollis*, we do not believe amelioration of this threat is required to downlist the species; therefore, though delisting criteria have been developed, downlisting criteria have not.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To reclassify *Cordylanthus mollis* ssp. *mollis* to threatened status, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, *downlisting* criteria under criteria A have been met and have resulted in at least the following:

Number of populations:
There must be nine or more *populations* in the Suisun Bay area and four or more *populations* around San Pablo Bay. A *population* shall be any concentration of plants separated by greater than one kilometer (0.6 mile) from other such concentrations of plants, with no intervening locations observed over a five year period.

Number of plants:
Median – Over five years of monitoring, each *population* must have a median number of 3,000 or more individuals.

Minimum – The entire species must not fall below 500 individuals for two consecutive years over a period of five years.

Seed production:

There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant.

Delisting criteria- Cordylanthus mollis ssp. *mollis*

Factor A: The present destruction, modification or curtailment of its habitat or range. To delist *Cordylanthus mollis* ssp. *mollis*, threats to the species habitat must be reduced or removed. This will have been accomplished if the following have occurred:

A/1. *Area inhabited* – The median area inhabited by the species in the Suisun Bay Area must be **6,000 acres** or more and the area inhabited by the species around San Pablo Bay must be **2,500 acres** or more. The area inhabited by the species shall be the sum of land areas of convex polygons enclosing individuals of each distinct *population*.

A/2. *Area preserved* – A total of **9,000 acres** or more in the Suisun Bay Area or around San Pablo Bay must be permanently preserved and under protective management. This must include existing or successfully restored *tidal marsh* areas with suitable habitat for the species and encompass at least 80 percent of the species *population*.

A/3. All *downlisting* criteria under A/3 have been achieved. In addition, a plan must be developed and implemented for early detection and control of *Lepidium latifolium* following any future increase beyond ten percent cover. Also, a funding source must be secured to fund such actions in perpetuity.

A/4. All *downlisting* criteria under A/4 must have been achieved.

A/5. All *downlisting* criteria under A/4 must have been achieved.

A/6. Trampling damage by grazed cattle and feral hogs to *Cordylanthus mollis* ssp. *mollis* and its *haustorial* connections to host plants must be eliminated at all *populations*.

A/7. Reliable propagation and *reintroduction* methods must be developed and available.

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization currently is not known to be a factor for this species. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to present a major threat to *Cordylanthus mollis* ssp. *mollis* at this time. However, to delist *Cordylanthus mollis* ssp. *mollis*, seed predation pressures need to be reduced or removed. This will have been accomplished if the following has occurred:

C/1. Pre-dispersal seed predator pressures on *Cordylanthus mollis* ssp. *mollis* from moth larvae (*Saphenista* spp., Tortricidae and salt marsh snout moth, *Lipographis fenestrella*, Pyralidae) must, on average, fall below 15 percent.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To delist *Cordylanthus mollis* ssp. *mollis*, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, *delisting* criteria under criteria A have been met and have resulted in at least the following:

Number of populations:
There must be **ten or more distinct populations in the Suisun Bay area and eight or more distinct populations around San Pablo Bay**. A distinct *population* shall be any concentration of plants with closest individuals to other *populations* greater than 1 kilometer (0.6 mile) apart over a period of five years.

Number of plants:
Median – **Over eight years of monitoring, each population must have a median number of 3,000 or more individuals; or if the species is widespread and abundant and is not divisible into distinct populations, there must be a median number over eight years of monitoring of 300,000 plants or more in the Suisun Bay Area and 300,000 or more plants around San Pablo Bay**

Minimum – The entire species must not fall below **1,000 individuals** for two consecutive years over a period of **eight years**.

Seed production:
There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant.

E/2. *Seed banking* of all existing *populations* and representative *genetic* diversity (per commonly accepted *seed banking* protocols) must be complete.

E/3. To minimize impacts sustained after oil spills occurring at or near core *populations*, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of *Cordylanthus mollis* ssp. *mollis*.

E/4. High *marsh*/upland transition lands, when and wherever possible, must be preserved or created as part of new *marsh* restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. In addition, there must be a partnership developed, involving resource agencies, public landowners/managers and private landowners, to implement Strategic Habitat Conservation (SHC), specifically to guide future habitat acquisition and management goals given the challenge of local sea level rise.

c. *Suaeda californica*

Downlisting criteria- Suaeda californica

Factor A: The present destruction, modification or curtailment of its habitat or range. To downlist *Suaeda californica* to threatened status, threats to the species habitat must be reduced. This will have been accomplished if the following have occurred:

A/1. In Morro Bay, dunes are partially revegetated with native species to achieve natural shoreline stability consistent with that which existed in historic dune systems.

A/2. Eradication of *Carpobrotus edulis* (iceplant) is conducted throughout potential habitat for *Suaeda californica* at Morro Bay.

A/3. Habitat supporting three or more *populations* in San Francisco Bay must exist on land in public or otherwise protected ownership.

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization is not known to be a threat to *Suaeda californica* at this time. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Neither disease nor predation is known to be a major threat to *Suaeda californica* at this time. Therefore, no recovery criteria are necessary for this factor.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To downlist *Suaeda californica* to threatened status, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, criteria under factor A have been met and have resulted in at least the following:
   i. Three separate *populations* at Morro Bay and vicinity totalling 3,000 plants or greater in each of five consecutive years.
   ii. Three separate *populations* at San Francisco Bay totalling 1,500 plants or greater in each of five consecutive years.

Delisting criteria- Suaeda californica

Factor A: The present destruction, modification or curtailment of its habitat or range. To delist *Suaeda californica*, threats to the species habitat must be reduced or removed. This will have been accomplished if the following have occurred:

A/1. All *downlisting* criteria under A/1 have been achieved.

A/2. All *downlisting* criteria under A/2 have been achieved. In addition, monitoring must indicate no presence of *C. edulis* for eight consecutive years.

A/3. Habitat supporting five or more *populations* in San Francisco Bay must exist on land in public or otherwise protected ownership for ten generations.

A/4. Management plans are implemented at Montaña de Oro State Park, Sweet Springs Marsh in Baywood Park, and Morro Bay State Marina to prevent trampling of *Suaeda californica* in those areas.

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization is not known to be a threat to *Suaeda californica* at this time. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Neither disease nor predation is known to be a major threat to *Suaeda californica* at this time. Therefore, no recovery criteria are necessary for this factor.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To delist *Suaeda californica*, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, criteria under factor A have been met and have resulted in at least the following:

i. Population at Morro Bay and vicinity of 5,000 plants or greater in each of ten consecutive years.

ii. Around San Francisco Bay:

a. at least three distinct populations, separated by 1.2 miles or more, each with 500 plants or greater in each of ten consecutive years, and each with at least 80 percent of the population on public or otherwise protected lands.

b. cumulative population throughout San Francisco Bay of 8,000 plants or greater in each of ten consecutive years.

E/2. To minimize impacts sustained after oil spills occurring at or near core *populations*, the San Francisco Bay and Delta Area and Central Coast Area sections of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of *Suaeda californica*.

E/3. High *marsh*/upland transition lands, when and wherever possible, must be preserved or created as part of new *marsh* restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. In addition, there must be a partnership developed, involving resource agencies, public landowners/managers and private landowners, to implement Strategic Habitat Conservation (SHC), specifically to guide future habitat acquisition and management goals given the challenge of local sea level rise.

Table III-2
Summary of *Cirsium hydrophilum* var. *hydrophilum, Cordylanthus mollis* ssp. *mollis,* and *Suaeda californica* Recovery Criteria

Criteria	*C. h.* var. *hydrophilum* Downlist	*C. h.* var. *hydrophilum* Delist	*C. m.* ssp. *mollis* Downlist	*C. m.* ssp. *mollis* Delist	*S. californica* Downlist	*S. californica* Delist
Factor A						
Minimum inhabited area (ac)	2,000 over 5 years	3,000 over 8 years (if not discreet *populations* then 4,000)	3,000 in Suisun Bay Area and 1,000 in San Pablo Bay over 5 years	6,000 in Suisun Bay Area and 2,500 in San Pablo over	-	-
Minimum preserved (ac)	4,000	6,000	5,000	9,000	3 locations in San Francisco Bay must be on preserved lands (no minimum acreage)	5 locations in San Francisco Bay must be on preserved lands (no minimum acreage); 80 percent of individuals in San Francisco Bay must be on protected lands
Reduction in Lepidium latifolium to less than 10 percent cover	X	X, plus maintain future infestations below 10 percent cover	X	X, plus maintain future infestations below 10 percent cover	-	-
Seed production	-	-	Median 10 seed capsules resulting in 15 mature seeds per plant	Median 10 seed capsules resulting in 15 mature seeds per plant	-	-
Restoration of natural *tidal* cycles at Hill Slough and ponded area at Rush	X	X	X	X	-	-

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Criteria	*C. h.* var. *hydrophilum* Downlist	*C. h.* var. *hydrophilum* Delist	*C. m.* ssp. *mollis* Downlist	*C. m.* ssp. *mollis* Delist	*S. californica* Downlist	*S. californica* Delist
Ranch						
Reliable restoration and *reintroduction* methods	-	X	-	X	-	-
Other *non-native* plant control	-	-	X (less than 10% cover of other *non-native*, *invasive perennial* or *non-native* winter *annual* grass species)	X (less than 10% cover of other *non-native*, *invasive perennial* or *non-native* winter *annual* grass species)	X (*Carpobrotus edulis* control at Morro Bay)	X (*C. edulis* control at Morro Bay. Must be 0% *C. edulis* for 8 consecutive years)
Elimination of trampling/rooting	-	X	-	X	-	X (via management plans at 3 sites in Morro Bay[1])
Partial dune revegetation in Morro Bay[1]	-	-	-	-	X	X
Natural recruitment	-	-	-	-	Recruitment at 3 localities resulting from San Francisco Bay reintroduced *populations*, for 10 generations each	Recruitment at 5 localities resulting from San Francisco Bay reintroduced *populations*, for 10 generations each
Factor C						
Predator management	X	X	X (must fall below 20%)	X (must fall below 15%)	-	-
Factor E						
Minimum # *populations*	3	4	9 in Suisun Bay Area; 4 in San Pablo Bay	10 in Suisun Bay Area; 8 in San Pablo Bay	3 in Morro Bay; 3 in San Francisco Bay	3 in Morro Bay; 3 in San Francisco Bay

Criteria	*C. h.* var. *hydrophilum* Downlist	*C. h.* var. *hydrophilum* Delist	*C. m.* ssp. *mollis* Downlist	*C. m.* ssp. *mollis* Delist	*S. californica* Downlist	*S. californica* Delist
Median # of plants	3,000 *total* over 5 years (if not discrete *populations*, then 5,000 total). Third largest *population* must have median of 300 individuals	4,000 *total* over 8 years (if not discreet *populations*, then 7,000 total)	3,000 *in each population* over 5 years	3,000 *in each population* over 8 years (if not discreet *populations*, then 300,000 around Suisun Bay Area; 300,000 around San Pablo Bay)	3,000 *total* over 5 consecutive years in Morro Bay; 1,500 *total* over 5 consecutive years in San Francisco Bay	5,000 *total* over 10 consecutive years in Morro Bay; 500 *in each population,* with a *total* of 8,000 in San Francisco Bay
Minimum species *population*	May not fall below 800 for two consecutive years	May not fall below 1,000 for two consecutive years	May not fall below 500 for two consecutive years	May not fall below 1,000 for two consecutive years	-	-
Seed banking accomplished	-	X	-	X	-	-
Research into hybridization, plus possible control of *Cirsium vulgare*	-	X	-	-	-	-
Oil spill response plans prepared to protect *populations*	-	X	-	X	-	X
High *marsh*/upland transition lands preserved or created and managed and partnershop formed	-	X	-	X	-	X

d. *California clapper rail*

Downlisting criteria- California clapper rail

Factor A: The present destruction, modification or curtailment of its habitat or range. To downlist California clapper rail to threatened status, threats to the species habitat must be reduced. This will have been accomplished if the following have occurred:

A/1. Protection and management of *marsh* complexes where core *populations* exist, as follows:

Central/Southern San Francisco Bay Recovery Unit (**Figure II-4**):

- Corte Madera marsh,
- Bair-Greco-Ravenswood,
- East Palo Alto-Guadalupe Slough,
- Guadalupe Slough-Warm Springs,
- Mowry-Dumbarton,
- Hwy 84 to Hwy 92 (Coyote Hills/Baumberg), and
- Cogswell-Hayward Shoreline/Oro Loma/Robert's Landing

Habitat Area: The habitat for each Central/South Bay core *population* (except that at Corte Madera marsh) must have a minimum area of 1,250 acres[3] (500 ha) of contiguous high-quality *tidal marsh* habitat with well-developed channel systems and high-*tide refugia*/escape cover, at the high *marsh*/upland transition zone and/or inner-*marsh*. Due to constraints on restorable land, habitat at Corte Madera marsh must be a minimum of 400 acres, and have the same critical characteristics, as stated previously.

A/2. Protection and management of *marsh* complexes where core *populations* exist, as follows:

San Pablo Bay Recovery Unit (**Figure III-3**):

- China Camp to Petaluma River,
- Petaluma River marshes,
- Petaluma River to Sonoma Creek,
- Napa marshes (Sonoma Creek to southern tip of Mare Island), and
- Point Pinole marsh

[3] The requirement for core *population* habitat area and characteristics is based on a calculated carrying capacity of more than 500 birds, assuming 0.45 bird/acre (1.1 birds/ha, the 90th percentile of observed South Bay winter *population* density) and represents the carrying capacity of high quality South Bay marshes. For more information on the calculation of carrying capacity, see **Appendix F**.

Habitat Area: The habitat area for each San Pablo Bay core *population*, except that at Point Pinole marsh, must have a minimum of 2,500 acres[4] (1,012 ha) of contiguous high-quality *tidal marsh* habitat with well-developed channel systems and high-*tide refugia*/escape cover, at the high *marsh*/upland transition zone and/or inner-*marsh*. Due to constraints on restorable land, habitat at Point Pinole marsh must be a minimum of 400 acres, and have the same critical characteristics, as stated previously.

A/3. Protection and management of *marsh* complexes where core *populations* exist, as follows:

Suisun Bay Area Recovery Unit (**Figure III-2**):

- Western Grizzly and Suisun Bays and marshes of Suisun, Hill and Cutoff Sloughs.

Habitat Area: The habitat area for the Suisun Bay area *population* must have a minimum of 5,000 acres[5] (2,023 ha) of contiguous high-quality *tidal marsh* habitat with well-developed channel systems and high-*tide refugia*/escape cover, at the high *marsh*/upland transition zone and/or inner-*marsh*.

A/4. **Protection and management of 800 acres[6] of habitat at Tomales Bay**, Marin County, to provide proximate, outercoast habitat for California clapper rail in the event of a *catastrophic* event within San Francisco Bay. The habitat must be contiguous high-quality *tidal marsh* habitat with well-developed channel systems and high-*tide refugia*/escape cover, at the high *marsh*/upland transition zone and/or inner-*marsh*.

A/5. **Control of extant invasive *Spartina alterniflora* and its hybrids and implementation of a system for its early detection**. The definition of control success shall be equivalent to that developed by the California Coastal Conservancy's Invasive *Spartina* Project: that the system as a whole shall have no net increase in acres of *invasive Spartina* as measured against the 2001 baseline. Due to hybridization issues, monitoring will use indicators of progress and regress relative to evolving definitions of treatment success.

A/6. Reduction in extant *Lepidium latifolium populations* to less than ten percent cover in each *marsh* complex described above**..**

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[4] *Population* densities in the San Pablo Bay have been historically lower than in the South Bay, with approximate density at the 90th percentile of 0.20 bird/acre (0.50 bird/ha) in high quality marshes adjacent to the bay, and 0.08 bird/acre (0.20 bird/ha) in more *brackish* marshes (Collins et. al. 1994). For more information on the calculation of carrying capacity, see **Appendix F**.

[5] *Population* densities in the Suisun Bay area have been historically lower and more highly variable than in the San Pablo and South Bays. Long-term monitoring data from which to obtain maximum observed *populations* is lacking, therefore, carrying capacity and average density at the 60th percentile could not be calculated. Instead, target density was developed in consultation with species experts.

[6] *Population* densities in maritime marshes of Marin County have been historically lower and more highly variable than in the San Pablo and South Bays. Long-term monitoring data from which to obtain maximum observed *populations* is lacking, therefore, carrying capacity and average density at the 60th percentile could not be calculated. Instead, target density was developed in consultation with species experts.

A/7. **Implementation of site-specific management plans on lands owned by U.S. Fish and Wildlife Service, California Department of Fish and Game, East Bay Regional Park District, and Mid-Peninsula Open Space District to reduce recreation-based (human-caused) disturbance** to rails, both by reduction of physical disturbance to rails from humans or dogs and by elimination of litter and feeding stations which serve to attract predators, thereby degrading habitat quality.

Factor B: Overutilization for commercial, scientific or educational purposes. Though overutilization was a major factor for this species at the turn of the 20th century and set the stage for low *population* levels which existed at the time of the original listing, it has been eliminated and is not currently known to be a threat. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to be a major threat to California clapper rails at this time. To downlist California clapper rail to threatened status, predation pressures need to be reduced. This will have been accomplished if the following have occurred:

C/1. A predator management plan is developed and implemented at all sites with significant predation issues.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To downlist California clapper rail to threatened status, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, criteria under factor A have been met and have resulted in at least the following average number of rails over a 10 year period, spread over a large geographic area:

i. Central/Southern San Francisco Bay: 1,185
ii. San Pablo Bay: 936
iii. Suisun Bay: 100

The average number of rails required for downlisting was calculated from the minimum required acreage above, derived itself from a *population* viability analysis conducted for California clapper rail. For further information on this analysis, see **Appendix F**. The minimum acreage was multiplied by the rail density cooresponding to the 60th percentile of observed winter *populations* for

that particular region. Respectively, those are 0.15 bird/ac, 0.09 bird/ac, and 0.02 bird/ac for the regions above.

For downlisting of the California clapper rail to occur, habitat protection need not have resulted in the occupation of Tomales Bay marshes by the species.

Delisting criteria- California clapper rail

Factor A: The present destruction, modification or curtailment of its habitat or range. To delist the California clapper rail, threats to the species habitat must be reduced or removed. This will have been accomplished if the following have occurred:

A/1. All *downlisting* criteria under A/1 have been achieved.

A/2. All *downlisting* criteria under A/2 have been achieved.

A/3. All *downlisting* criteria under A/3 have been achieved.

A/4. All *downlisting* criteria under A/4 have been achieved.

A/5. All *downlisting* criteria under A/5 have been achieved. In addition, a plan for control following any future detections of *Spartina alterniflora* or its hybrids must be in place. The definition of control success shall be equivalent to that developed by the California Coastal Conservancy's Invasive *Spartina* Project: that the system as a whole shall have no net increase in acres of *invasive Spartina* as measured against the 2001 baseline. Due to hybridization issues, monitoring will use indicators of progress and regress relative to evolving definitions of treatment success.

A/6. All *downlisting* criteria under A/6 have been achieved. In addition, a plan must be developed and implemented for early detection and control of *Lepidium latifolium* following any future increase beyond ten percent cover. Also, a funding source must be secured to fund such actions in perpetuity.

A/7. *Downlisting* criteria under A/7 have been achieved **at all sites**.

A/8. Implementation of the *Habitat Management, Preservation, and Restoration Plan for Suisun Marsh* (in preparation by the Suisun Marsh Charter Group[7]), San Pablo Bay National Wildlife Refuge Comprehensive Conservation Plan (in preparation by San Pablo

[7] A multi-agency group with primary responsibility to protect and enhance the Pacific Flyway and existing wildlife values, endangered species, and water-project supply quality in Suisun Marsh. Members include U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Bureau of Reclamation (BOR), California Department of Fish and Game, California Department of Water Resources, California Bay-Delta Authority, and Suisun Resource Conservation District.

Bay National Wildlife Refuge), and the *South Bay Salt Pond Restoration Plan* (U.S. Fish and Wildlife Service 2009).

Factor B: Overutilization for commercial, scientific or educational purposes. Though overutilization was a major factor for this species at the turn of the 20th century and set the stage for low *population* levels which existed at the time of the original listing, it has been eliminated and is not currently known to be a threat. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to present a major threat to California clapper rails at this time. To delist California clapper rail, predation pressures need to be reduced or removed. This will have been accomplished if the following have occurred:

C/1. All *downlisting* criteria under C/1 have been achieved. In addition, predator monitoring indicates that for 5 consecutive years, predation pressure on California clapper rails falls below a level at which it negatively affects long-term *population* persistence.

Factor D: Inadequacy of existing regulatory mechanisms. . We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To delist California clapper rail, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following have occurred:

E/1. To provide sufficient *resilience* to stochastic events, criteria A/1 and A/2 have been met and have resulted in at least the following average number of rails over a 10 year period, spread over a large geographic area:

i. Central/So SF Bay: 1,975
ii. San Pablo Bay: 1,248
iii. Suisun Bay: 200
iv. Tomales Bay: 200

The average number of rails required for downlisting was calculated from the minimum required acreage above, derived itself from a *population* viability analysis conducted for California clapper rail. For further information on this analysis, see **Appendix F**. The minimum acreage was multiplied by the rail density cooresponding to the 75th percentile of observed winter *populations* for that particular region. Respectively, those are 0.25 bird/ac, 0.12 bird/ac, 0.04 bird/ac, and 0.04 bird/ac for the regions above.

E/2. To minimize impacts sustained after oil spills occurring at or near core *populations*, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of California clapper rails.

E/3. A map must be developed which identifies sources and extents of mercury exposure in rails and a plan must be in place to remediate the most significant point sources of mercury. In addition, exposure of rails to mercury must be reduced such that mercury concentrations in rail eggs fall below 0.2 ppm (fresh wet weight), the point above which it is believed developmental abnormalities and reproductive harm occur.

E/4. High *marsh*/upland transition lands, when and wherever possible, must be preserved or created as part of new *marsh* restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. In addition, there must be a partnership developed, involving resource agencies, public landowners/managers and private landowners, to implement Strategic Habitat Conservation[8] (SHC), specifically to guide future habitat acquisition and management goals given the challenge of local sea level rise.

e. *Salt marsh harvest mouse*

Downlisting criteria- Salt marsh harvest mouse

Factor A: The present destruction, modification or curtailment of its habitat or range. To reclassify the salt marsh harvest mouse to threatened status, threats to the species habitat must be reduced. This will have been accomplished if the following have occurred:

Protection, management and restoration of suitable tidal marsh habitat in each marsh complex sufficient to support multiple viable habitat areas occupied by salt marsh harvest mice, that are distributed among recovery units as specified below in criteria A/1 through A-4.

Each *marsh* complex must be as large and of as high a habitat quality as possible. These high quality *marsh* complexes will support larger *populations* of salt marsh harvest mice, and these complexes will likely persist, even in the face of such challenges as rising sea levels. Each *marsh* complex must meet a minimum acreage size, as specified below.

Marsh complexes will be comprised of one or more *viable* habitat areas (VHAs). *Viable* habitat areas for the salt marsh harvest mouse in the Central/Southern San Francisco Bay Recovery Unit, and San Pablo Bay Recovery Unit are defined as well-developed *tidal*

[8] Strategic Habitat Conservation (SHC) is an adaptive management approach to conservation planning, implementation, and evaluation. SHC was developed by a team of scientists to meet the challenges of wildlife conservation in the nation and to include up-to-date technologies and methods.

marshes with the following specific features: 1) extensive *Sarcocornia* (pickleweed) on a mid to high *marsh* plain 200 meters or more deep (from shore to bay); 2) adjacent wide high *marsh* transition zone, wherever possible, that acts as a refugium for the mice during the highest *tides* with sufficient area and cover to minimize predation risks and; 3) stands of *Grindelia* (and in San Pablo Bay area, *Scirpus* spp.) or tall forms of *Sarcocornia*, interspersed among shorter forms of *Sarcocornia* to provide additional high *tide refugia* within the *marsh* and away from the upland edge.

In addition, *viable* habitat areas for salt marsh harvest mice in the *Suisun Bay Area Recovery Unit* may be defined as muted, as well as fully *tidalmarsh*. *Viable* habitat areas in the Suisun Bay Area Recovery Unit include the above important habitat features, but also include interspersed taller vegetation (*Scirpus* and other species that are documented to be used by salt marsh harvest mice) (California Department of Water Resources *in litt*. 2007) as additional high *tide refugia*. Currently, a large proportion of salt marsh harvest mice in Suisun Marsh are supported by *diked* wetlands on Grizzly Island. Because of this and because lands here are severely subsided and would be nearly impossible to restore to *tidal* conditions, *diked* wetland acreage may be substituted for *tidal marsh* habitat when counting toward the *viable* habitat area acreage target within the Grizzly Island Marsh Complex only.

All VHAs within each *marsh* complex must be 150 acres or more, the minimum acreage thought to sustain a healthy mouse *population* (Shellhammer *in litt*. 2005). The VHAs must be connected by *corridors* broad and complex enough to allow the interconnected VHAs to function as one large *population* over time; however, these *corridors* will not be counted in the total *marsh* complex acreage, unless they are fringing marshes 500 feet deep (from shore to bay) or deeper and have excellent escape cover and some degree of high *marsh* transition zone.

Population criteria are based on capture efficiency data (*i.e.*, number of mice captured divided by effort in number of trap nights[9] expended times 100) because of high effort-low return on trapping and the great difficulty and great expense of obtaining dependable density estimates on a regular basis. Occupancy of multiple VHAs within a *marsh* complex at a capture efficiency level of 5.0 or better in some and 3.0 or better in most of the remaining VHAs is the primary indicator of a mouse *population* heading toward sustainability, while cccupancy of multiple VHAs within a *marsh* complex at a capture efficiency level of 5.0 or better in most of the habitat areas is the primary indicator of a sustainable *population* (Shellhammer pers. comm. 2005). The specific trap layout and spacing per site may differ.

Recovery Units, Marsh Complexes, Viable Habitat Areas

A/1. Central/Southern San Francisco Bay Recovery Unit (**Figure III-4**): historic and restored *marsh* complexes at:

Corte Madera Marsh, 400 or more acres in size, with one VHA at:

- Corte Madera Marsh (State Ecological Area)

[9] A measure of trapping effort, *e.g.*, 400 trap nights represents 100 traps set for 4 nights.

Bair-Greco-Ravenswood, 1,000 or more acres in size, with VHAs at:
- Foster City
- Bair Island
- Greco-Westpoint and Flood Sloughs
- Ravenswood Point and Slough

East Palo Alto-Guadalupe Slough, 1,000 or more acres in size, with VHAs at:
- East Palo Alto- Cooley Landing- Palo Alto Nature- Mountain View to Stevens Creek
- Stevens Creek to Guadalupe Slough

Guadalupe Slough-Warm Springs, 1,000 or more acres in size, with one VHA within the *marsh* complex

Calaveras-Mowry-Dumbarton, 1,000 or more acres in size, with one VHA within the *marsh* complex

Hwys 84 to 92 (Coyote Hills-Baumberg), 1,000 or more acres in size, with VHAs at:
- Hwy 84 to Coyote Hills Slough
- Coyote Hills Slough to Hwy 92

Cogswell-Hayward Shoreline, Oro Loma, Roberts Landing, 1,000 or more acres in size, with VHAs at:
- Cogswell-Hayward Shoreline
- Oro Loma
- Roberts Landing

Sub-criterion A: Protection of Documented Occurrences
Habitat supporting all documented salt marsh harvest mouse occurrences must be protected via habitat management.

Sub- criterion B: VHA Characteristics
Each *marsh* complex must support VHAs, as described above, and these areas shall be connected by suitable habitat *corridors* with sufficiently deep (from shore to bay) pickleweed plains and/or sufficiently deep high *marsh* zones (and preferably both). This will allow movement of salt marsh harvest mice through these areas to occur unobstructed.

Sub- criterion C: Marsh Connectivity
Wherever possible, the *marsh* complexes themselves must be connected to one another by *marsh* or restored *tidal marsh* of sufficient depth and complexity to allow for dispersal and recolonization.

Sub- criterion D: Marsh Complex Minimum Acreage
Marsh complexes must be 1,000 acres or more in size, except in Corte Madera marsh where, due to constraints on restorable habitat, the *marsh* complex must be 400 acres or more in size. All VHAs within each *marsh* complex must be 150 acres or more in size.

A/2. San Pablo Bay Recovery Unit (**Figure III-3**): historic and restored *marsh* complexes at:

China Camp to the mouth of the Petaluma River, 1,000 or more acres in size, with VHAs at:
- China Camp to Gallinas Creek and Gallinas Creek
- Hamilton Air Force Base marshes to Petaluma Point, including Novato Creek

Petaluma River marshes, 1,000 or more acres in size, with VHAs at:
- Bahia-Black John Slough-mouth of San Antonio Creek
- Petaluma Marsh and east of Petaluma River
- South-east of Petaluma Marsh

Mouth of the Petaluma River to the mouth of Sonoma Creek, 1,000 or more acres in size, with one VHA within the *marsh* complex

Napa marshes from the mouth of Sonoma Creek to the southern tip of Mare Island, 1,000 or more acres in size, with six VHAs within the *marsh* complex. These areas are dependant on the locations of the restored marshes.

Point Pinole marsh, 400 or more acres in size, with one VHA at:
- San Pablo Creek marshes and northeast from mouth of San Pablo Creek

Sub- criterion A: Protection of Documented Occurrences
Habitat supporting documented salt marsh harvest mouse occurrences must be protected via habitat management.

Sub- criterion B: VHA Characteristics
Each *marsh* complex must support VHAs, as described above, and these areas shall be connected by suitable habitat *corridors* with sufficiently deep (from shore to bay) pickleweed plains and/or sufficiently deep high *marsh* zones (and preferably both). This will allow movement of salt marsh harvest mice through these areas to occur unobstructed.

Sub- criterion C: Marsh Connectivity
Wherever possible, the *marsh* complexes themselves must be connected to one another by *marsh* or restored *tidal marsh* of sufficient depth and complexity to allow for dispersal and recolonization.

Sub- criterion D: Marsh Complex Minimum Acreage
Marsh complexes must be 1,000 acres or more in size, except in Point Pinole marsh where, due to constraints on restorable habitat, the *marsh* complex must be 400 acres or more in size. All VHAs within each *marsh* complex must be 150 acres or more in size.

A/3. Suisun Bay Area Recovery Unit (**Figure III-2**): historic and restored *marsh* complexes at:

Western Suisun/Hill Slough Marsh Complex, 1,000 or more acres, with VHAs at:
- Morrow Island
- Cordelia Slough (west of railroad tracks)
- Chadbourne/Upper Wells Slough (west *and* east of railroad tracks)
- Peytonia
- Hill Slough complex

Suisun Slough/Cutoff Slough Marsh Complex, 1,000 or more acres, with VHAs at:
- Lower Joice Island
- Upper Joice Island
- Rush Landing to Beldon's Landing (east of Suisun and Cutoff Sloughs)
- Beldon's Landing to Nurse Slough

Grizzly Island Marsh Complex, 1,500 or more acres, with VHAs at:
- Grizzly Island West
- East border of Grizzly Bay, plus Crescent unit
- Grizzly Island East, including Ponds 1 and 15
- Simmons-Wheeler Islands
- Van Sickle Island/Chipps Island
- Ryer Island
- Montezuma area

Nurse Slough/Denverton Slough Marsh Complex, 1,000 or more acres, with VHAs at:
- Bradmoor Island- Little Honker Bay
- Blacklock
- Upper Nurse Slough

Contra Costa County Shoreline Marsh Complex, 500 or more acres, with VHAs at:
- Mallard Slough East
- Concord Naval Weapons Station marshes
- Hastings Slough to Carquinez Bridge

Sub- criterion A: Protection of Documented Occurrences
Habitat supporting documented salt marsh harvest mouse occurrences must be protected via habitat management.

Sub- criterion B: VHA Characteristics
Each *marsh* complex must support VHAs, as described above, and these areas shall be connected by suitable habitat *corridors* with sufficiently deep (from shore to bay) pickleweed plains and/or sufficiently deep high *marsh* zones (and preferably both). This will allow movement of salt marsh harvest mice through these areas to occur unobstructed. Isolated salt marsh harvest mouse preserves must be large enough to support mouse *populations* that will not lose *genetic* diversity due to random *genetic* drift over time.

Sub- criterion C: Marsh Connectivity
Wherever possible, the *marsh* complexes themselves must be connected to one another by suitable habitat of sufficient depth and complexity to allow for dispersal and re-colonization.

Sub- criterion D: Marsh Complex Minimum Acreage
Most *marsh* complexes must be 1,000 or more acres in size. However, the Grizzly Island Marsh Complex must be 1,500 or more acres and the Contra Costa County Shoreline Marsh Complex must be 500 or more acres in size. All VHAs within each *marsh* complex must be 150 acres or more in size. Individual Mouse Conservation Areas, as defined above in Chapter I under Tidal marsh conservation, restoration, and management, must be 150 or more acres in size and must have *corridors* to other preserves and/or to suitable habitat supporting salt marsh harvest mouse, wherever possible.

A/4. **Treatment of extant invasive *Spartina alterniflora* and its hybrids and implementation of a system for its early detection**. The definition of treatment success shall be equivalent to that developed by the California Coastal Conservancy's Invasive *Spartina* Project: that the system as a whole shall have no net increase in acres of *invasive Spartina* as measured against the 2001 baseline. Due to hybridization issues, monitoring will use indicators of progress and regress relative to evolving definitions of treatment success.

A/5. Reduction in extant *Lepidium latifolium populations* to less than ten percent cover in each *marsh* complex described above.

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization currently is not known to be a factor for this species. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to be a major threat to the salt marsh harvest mouse at this time. Unnatural predation is thought to exist in some marshes where salt marsh harvest mice are concentrated into narrow *Sarcocornia* zones due to surrounding habitat loss. Though little is known about death rates related to the resulting predation, it is presumed that restoration of deep marshes with ample high *tide refugia*, both high *marsh* and intermarsh, will result in a reduction of predation rates. Therefore, focus is given to restoration of high quality marshes and no recovery criteria related to predation are suggested.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To reclassify the salt marsh harvest mouse to threatened status, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following has occurred in the Central/Southern San Francisco Bay, San Pablo Bay, and Suisun Bay Area Recovery Units (**Figures III-2 through III-4**):

E/1. **Marsh Complex Population Occupancy Targets associated with A/1 through A/3**

- 40% of the VHAs of each large *marsh* complex must have salt marsh harvest mice present at the capture efficiency level of 5.0 or better AND
- 50% of the VHAs of each large *marsh* complex must have salt marsh harvest mice present at the capture efficiency level of 3.0 or better.
- Each *marsh* complex must be monitored and found to meet the above criteria at least twice, with at least 5 years between surveys. Some *marsh* complexes may meet the target after only two surveys while it may take more than two surveys for other *marsh* complexes (restored marshes which eventually establish suitable habitat) to meet the target. After *marsh* complexes meet the criteria twice, there is no need to resurvey them, as long as no more than 20 years has passed and there has been no obvious negative change to habitat during that time (*i.e.*, substantial loss of upland transition or high *marsh refugia* due to sea level rise).

Delisting criteria- Salt marsh harvest mouse

Factor A: The present destruction, modification or curtailment of its habitat or range. To delist the salt marsh harvest mouse, threats to the species habitat must be reduced. This will have been accomplished if the following have occurred:

A/1. All *downlisting* criteria under A/1 have been achieved.

A/2. All *downlisting* criteria under A/2 have been achieved.

A/3. All *downlisting* criteria under A/3 have been achieved.

A/4. All *downlisting* criteria under A/4 have been achieved. In addition, a plan for eradication following any future detections of *Spartina alterniflora* or its hybrids must be in place. The definition of treatment success shall be equivalent to that developed by the California Coastal Conservancy's Invasive *Spartina* Project: that the system as a whole shall have no net increase in acres of *invasive Spartina* as measured against the 2001 baseline. Due to hybridization issues, monitoring

will use indicators of progress and regress relative to evolving definitions of treatment success.

A/5. All *downlisting* criteria under A/5 have been achieved. In addition, a plan must be developed and implementated for early detection and control of *Lepidium latifolium* following any future increase beyond ten percent cover. Also, a funding source must be secured to fund such actions in perpetuity.

A/6. Implementation of the *Habitat Management, Preservation, and Restoration Plan for Suisun Marsh* (in preparation by the Suisun Marsh Charter Group[10]), San Pablo Bay National Wildlife Refuge Comprehensive Conservation Plan (in preparation by San Pablo Bay National Wildlife Refuge), and the *South Bay Salt Pond Restoration Plan* (U.S. Fish and Wildlife Service 2009).

Factor B: Overutilization for commercial, scientific or educational purposes. Overutilization currently is not known to be a factor for this species. Therefore, no recovery criteria are necessary for this factor.

Factor C: Disease or predation. Disease is not known to present a major threat to the salt marsh harvest mouse at this time. Unnatural predation is thought to exist in some marshes where salt marsh harvest mice are concentrated into narrow *Sarcocornia* zones due to surrounding habitat loss. Though little is known about death rates related to resulting predation, it is presumed that restoration of deep marshes with ample high *tide refugia*, both high *marsh* and intermarsh, will result in a reduction of predation rates. Therefore, focus is given to restoration of high quality marshes and no recovery criterion related to predation threat is provided. Therefore, no recovery criteria specific to this factor are necessary.

Factor D: Inadequacy of existing regulatory mechanisms. We believe that if the threats under factors A, C and E are ameliorated, then additional regulatory mechanisms (beyond existing ones) are not necessary. Therefore, we are not proposing recovery criteria under this factor.

Factor E: Other natural or manmade factors affecting its continued existence. To delist the salt marsh harvest mouse, the species must be protected from other natural or manmade factors known to affect its continued existence. This will have been accomplished if the following has occurred in the Central/Southern San Francisco Bay, San Pablo Bay, and Suisun Bay Area Recovery Units (**Figures III-2 through III-4**):

In addition to meeting all downlisting criteria above, to delist the salt marsh harvest mouse, a higher *population* occupancy target (Sub-criteria E) must be met, as follows:

[10] A multi-agency group with primary responsibility to protect and enhance the Pacific Flyway and existing wildlife values, endangered species, and water-project supply quality in Suisun Marsh. Members include U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Bureau of Reclamation (BOR), California Department of Fish and Game, California Department of Water Resources, California Bay-Delta Authority, and Suisun Resource Conservation District.

E/1. **Marsh Complex Population Occupancy Targets associated with A/1 through A/3**

- **75% of defined VHAs within each of the marsh complexes must have salt marsh harvest mice consistently present at the capture efficiency level of 5.0 or better.**
- As with the downlisting criteria, each *marsh* complex must be monitored and found to meet the above criteria at least twice, with at least 5 years between surveys. Some *marsh* complexes may meet the target after only two surveys while it may take more than two surveys for other *marsh* complexes (restored marshes which eventually establish suitable habitat) to meet the target. After *marsh* complexes meet the criteria twice, there is no need to resurvey them, as long as no more than 20 years has passed and there has been no obvious negative change to habitat during that time (*i.e.*, substantial loss of upland transition or high *marsh refugia* due to sea level rise).

E/2. To minimize impacts sustained after oil spills occurring at or near core *populations*, the San Francisco Bay and Delta Area section of the Sector San Francisco- Area Contingency Plan must be revised to place high priority on the emergency protection of salt *marsh* harvest mice.

E/3. High *marsh*/upland transition lands, when and wherever possible, must be preserved or created as part of new *marsh* restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. In addition, there must be a partnership developed, involving resource agencies, public landowners/managers and private landowners, to implement Strategic Habitat Conservation (SHC), specifically to guide future habitat acquisition and management goals given the challenge of local sea level rise.

Table III-3
Summary of California Clapper Rail and Salt Marsh Harvest Mouse Recovery Criteria

Marsh Complexes	California clapper rail-Downlist	California clapper rail-Delist	Salt marsh harvest mouse-Downlist	Salt marsh harvest mouse-Delist
CENTRAL/SOUTHERN SAN FRANCISCO BAY RECOVERY UNIT				
Corte Madera marsh	Minimum acreage[11]: 400 ac Recovery Unit target (10-yr mean) = 1,185 birds	Minimum acreage: 400 ac Minimum density in any yr.: 0.15 bird/acre Recovery Unit target (10-yr mean) = 1,975 birds	Minimum acreage: 400 ac 1 VHA[12] 40% of VHA with CE[13] of 5.0 or greater **AND** 50% of VHA with CE of 3.0 or greater VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 400 ac 1 VHA 75% of VHAs with CE of 5.0 or greater VHA monitored twice with 2-5 yrs between efforts
Bair-Greco-Ravenswood	Minimum acreage: 1,250 ac Recovery Unit target (10-yr mean) = 1,185 birds	Minimum acreage: 1,250 ac Minimum density in any yr.: 0.15 bird/acre Recovery Unit target (10-yr mean) = 1,975 birds	Minimum acreage: 1,000 ac 4 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 4 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts
East Palo Alto-Guadalupe Slough	Minimum acreage: 1,250 ac Recovery Unit target (10-yr mean) 1,185 birds	Minimum acreage: 1,250 ac Minimum density in any yr.: 0.15 bird/acre Recovery Unit target (10-yr mean) 1,975 birds	Minimum acreage: 1,000 ac 2 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 2 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts

[11] Minimum acreage is defined as minimum acreage of suitable restored or existing tidal marsh habitat. In Suisun marsh, this may include suitable *diked* wetland habitat.
[12] VHA = Viable Habitat Area. Described in downlisting criteria for salt marsh harvest mouse.
[13] CE = Capture Efficiency. Described in downlisting criteria for salt marsh harvest mouse.

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Marsh Complexes	California clapper rail-Downlist	California clapper rail-Delist	Salt marsh harvest mouse-Downlist	Salt marsh harvest mouse-Delist
Guadalupe Slough-Warm Springs	Minimum acreage: 1,250 ac Recovery Unit target (10-yr mean) = 1,185 birds	Minimum acreage: 1,250 ac Minimum density in any yr.: 0.15 bird/acre Recovery Unit target (10-yr mean) = 1,975 birds	Minimum acreage: 1,000 ac 1 VHA 40% of VHA with CE of 5.0 or greater **AND** 50% of VHA with CE of 3.0 or greater VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 1 VHA 75% of VHAs with CE of 5.0 or greater VHA monitored twice with 2-5 yrs between efforts
Calaveras-Mowry-Dumbarton	Minimum acreage: 1,250 ac Recovery Unit target (10-yr mean) = 1,185 birds	Minimum acreage: 1,250 ac Minimum density in any yr.: 0.15 bird/acre Recovery Unit target (10-yr mean) = 1,975 birds	Minimum acreage: 1,000 ac 1 VHA 40% of VHA with CE of 5.0 or greater **AND** 50% of VHA with CE of 3.0 or greater VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 1 VHA 75% of VHAs with CE of 5.0 or greater VHA monitored twice with 2-5 yrs between efforts
Hwy 84 to Hwy 92	Minimum acreage: 1,250 ac Recovery Unit target (10-yr mean) = 1,185 birds	Minimum acreage: 1,250 ac Minimum density in any yr.: 0.15 bird/acre Recovery Unit target (10-yr mean) = 1,975 birds	Minimum acreage: 1,000 ac 2 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 2 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts
Cogswell-Hayward Shoreline/Oro Loma/Robert's Landing	Minimum acreage: 1,250 ac Recovery Unit target (10-yr mean) 1,185 birds	Minimum acreage: 1,250 ac Minimum density in any yr.: 0.15 bird/acre Recovery Unit target (10-yr mean) = 1,975 birds	Minimum acreage: 1,000 ac 3 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 3 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts

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Marsh Complexes	California clapper rail-Downlist	California clapper rail-Delist	Salt marsh harvest mouse-Downlist	Salt marsh harvest mouse-Delist
SAN PABLO BAY RECOVERY UNIT				
China Camp to Petaluma River	Minimum acreage: 2,500 ac Recovery Unit target (10-yr mean) = 936 birds	Minimum acreage: 2,500 ac Minimum density in any yr.: 0.09 bird/acre Recovery Unit target (10-yr mean) = 1,248 birds	Minimum acreage: 1,000 ac 2 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 2 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts
Petaluma River marshes	Minimum acreage: 2,500 ac Recovery Unit target (10-yr mean) 936 birds	Minimum acreage: 2,500 ac Minimum density in any yr.: 0.09 bird/acre Recovery Unit target (10-yr mean) 1,248 birds	Minimum acreage: 1,000 ac 3 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 3 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts
Petaluma River to Sonoma Creek	Minimum acreage: 2,500 ac Recovery Unit target (10-yr mean) = 936 birds	Minimum acreage: 2,500 ac Minimum density in any yr.: 0.09 bird/acre Recovery Unit target (10-yr mean) = 1,248 birds	Minimum acreage: 1,000 ac 1 VHA 40% of VHA with CE of 5.0 or greater **AND** 50% of VHA with CE of 3.0 or greater VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 1 VHA 75% of VHAs with CE of 5.0 or greater VHA monitored twice with 2-5 yrs between efforts
Napa marshes	Minimum acreage: 2,500 ac Recovery Unit target (10-yr mean) = 936 birds	Minimum acreage: 2,500 ac Minimum density in any yr.: 0.09 bird/acre Recovery Unit target (10-yr mean) = 1,248 birds	Minimum acreage: 1,000 ac 12 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater	Minimum acreage: 1,000 ac 12 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts

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Marsh Complexes	California clapper rail-Downlist	California clapper rail-Delist	Salt marsh harvest mouse-Downlist	Salt marsh harvest mouse-Delist
			Each VHA monitored twice with 2-5 yrs between efforts	
Point Pinole marshes	Minimum acreage: 400 ac Recovery Unit target (10-yr mean) = 936 birds	Minimum acreage: 400 ac Minimum density in any yr.: 0.09 bird/acre Recovery Unit target (10-yr mean) = 1,248 birds	Minimum acreage: 400 ac 1 VHA 40% of VHA with CE of 5.0 or greater **AND** 50% of VHA with CE of 3.0 or greater VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 400 ac 1 VHA 75% of VHAs with CE of 5.0 or greater VHA monitored twice with 2-5 yrs between efforts
SUISUN BAY AREA RECOVERY UNIT **(This recovery unit considered one large marsh complex for California clapper rail)**				
Western Suisun/ Hill Slough marshes	Minimum acreage: 5,000 ac Recovery Unit target (10-yr mean) = 100 birds	Minimum acreage: 5,000 ac Recovery Unit target (10-yr mean) = 200 birds	Minimum acreage: 1,000 ac 5 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 5 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts
Suisun Slough/Cutoff Slough marshes			Minimum acreage: 1,000 ac 4 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 4 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts
Grizzly Island marshes			Minimum acreage: 1,500 ac 7 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater	Minimum acreage: 1,500 ac 7 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts

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Marsh Complexes	California clapper rail-Downlist	California clapper rail-Delist	Salt marsh harvest mouse-Downlist	Salt marsh harvest mouse-Delist
			Each VHA monitored twice with 2-5 yrs between efforts	
Nurse Slough/ Denverton marshes			Minimum acreage: 1,000 ac 3 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 1,000 ac 3 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts
Contra Costa County shoreline marshes			Minimum acreage: 500 ac 3 VHAs 40% of VHAs with CE of 5.0 or greater **AND** 50% of VHAs with CE of 3.0 or greater Each VHA monitored twice with 2-5 yrs between efforts	Minimum acreage: 500 ac 3 VHAs 75% of VHAs with CE of 5.0 or greater Each VHA monitored twice with 2-5 yrs between efforts

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Additional Criteria				
Criterion	**California clapp rail-Downlist**	**California clapper rail-Delist**	**Salt marsh harvest Mouse-Downlist**	**Salt marsh harvest Mouse-Delist**
Factor A				
Protection/ management of habitat at Tomales Bay	X	X	-	-
***Spartina alterniflora* control**	X	X	X	X
***Reduction of Lepidium latifolium* to less than 10 percent cover**	X	X, plus maintain future infestations below	X, plus maintain futu infestations below 10 percent cover	X

		10 percent cover		
Implementation of *Habitat Management, Preservation Restoration Plan for Suisun Marsh* (in preparation), San Pablo Bay Comprehensive Conservation Plan (in preparation), and the *South Bay Salt Pond Restoration Plan*.	-	X	-	X
Implementation of management plans[1] to reduce recreation-based disturbance	X	X	-	-
Factor C				
Predator management	X	X	-	-
Factor E				
Reduction of mercury exposure	-	X	-	-
Oil spill response plans developed to protect species	-	X	-	X
High marsh/upland transition lands preserved or created and managed and partnership formed	-	X		X

[1] Specific sites described in text.

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B. SPECIES RECOVERY AND CONSERVATION STRATEGIES

This section describes recovery and conservation strategies at three basic levels: ecosystem-level, regional-level, and species-level- each stepped down in increasing detail. Ecosystem-level recovery strategies are aimed at reducing or eliminating ecosystem-level threats. These general strategies address the common threats to most or all of the species covered by this draft recovery plan (and discussed in section I.D.), as well as the *tidal marsh* ecosystem upon which they depend. Some combination of the ecosystem-level strategies will be stepped down and applied at the regional level, depending upon the local threats and constraints of the covered species historically or currently present. A detailed discussion of strategies by region follows in section III.B.2. Finally, some threats are very specific to individual *tidal marsh* species, as opposed to the ecosystem or the region as a whole. Recovery strategies specific to particular species will be discussed in section III.B.3.

Due to shifting conditions in the ecosystem (*e.g., invasive* species, sea level rise) and an evolving understanding of *tidal marsh* ecology in California, the U.S. Fish and Wildlife Service anticipates the need to adapt these strategies over time to meet new situations. Ideally, recovery strategies will supplement and complement effective *tidal marsh* conservation efforts that have already taken place or are underway.

1. Ecosystem-level recovery strategies

The following five ecosystem-level strategies are described further below:

- **Acquire existing, historic, and restorable tidal marsh habitat** to promote the recovery of listed species and long-term conservation of species of concern and other *tidal marsh* species.

- **Manage, restore, and monitor tidal marsh habitat** to promote the recovery of listed species and the long-term conservation of species of concern and other *tidal marsh* species covered in this draft recovery plan.

- **Conduct range-wide species status surveys/monitoring and status reviews** for species covered in this draft recovery plan.

- **Conduct research** necessary to the recovery of listed species and long-term conservation of species of concern and other *tidal marsh* species covered in this draft recovery plan.

- **Improve coordination, participation, and outreach activities** to achieve recovery of listed species and long-term conservation of species of concern.

1. Acquire existing, historic, and restorable tidal marsh habitat to promote the recovery of listed species and long-term conservation of species of concern and other tidal marsh species covered in this draft recovery plan.

The limited amount of available habitat--much of it important to the conservation and recovery of various rare, threatened, or endangered species--makes protection of remaining *tidal marsh* habitat essential. Habitat loss and fragmentation is the primary reason that *tidal marsh* species are in danger of extinction, so additional habitat loss is counterproductive to recovery. *Genetic* diversity within each species must be retained to increase its likelihood of persisting through unpredictable events (*e.g.,* drought, climate change). *Genetic* composition has not been investigated for most of the featured taxa, so protection of remaining *populations* is prudent. Retaining the full range of site diversity in which a species occurs (as a surrogate for *genetic* diversity) increases the likelihood of persistence under unpredictable future environmental conditions.

Habitat protection includes permanent protection of landscape, topographic, and soil features that support hydrologically and ecologically functional *tidal marsh* ecosystems, including space for erosional and depositional dynamics, upland transition zones, and sea level rise. To protect remaining habitat, it is desirable to acquire privately owned *tidal marsh* habitat, restorable areas, or buffer land, from willing sellers, in fee title or conservation easement. Acquisition projects should consider the ability of a site to accommodate a range of sea level rise scenarios. The addition of habitat to conservation ownership will enhance restoration and management options over larger areas, and increase continuity and functionality of *tidal marsh* habitats.

From a regulatory standpoint, strict protection of *tidal marsh* should not be followed blindly, without an understanding of the larger restoration goal. For example, it likely would be advantageous to the ecosystem to eradicate *non-native* cordgrass in an existing *marsh*, even though it may require temporary destruction of native *marsh* vegetation in the short-term.

The Stepdown Narrative below includes actions to identify and protect remaining *tidal marsh* areas, as well as a series of research actions to characterize, maintain, and restore functional *tidal marsh* ecosystems.

2. *Manage, restore, and monitor tidal marsh habitat to promote the recovery of listed species and the long-term conservation of species of concern and other tidal marsh species.*

Managing, restoring, and monitoring *tidal marsh* ecosystems will speed the recovery process. Methods for effective habitat management, restoration, and monitoring in *tidal marsh* ecosystems are continuously being evaluated and improved. Strategies to manage, restore, and monitor *tidal marsh* areas therefore must remain *adaptive* (*i.e.,* responsive) and must be tied to *population* and ecosystem trends. Where *populations* of species covered in this plan are currently stable or increasing, existing habitat management may be adequate, but if *populations* or habitats of covered species begin to decline, changes in management must be considered. For *populations* that are declining, revised habitat management techniques must be based on the best available scientific data, research, or observed outcomes of management from similar situations. Planning for restoration, management, and monitoring is important, as is maintaining the flexibility to adapt plans in response to new developments or new information.

Management-- Appropriately *managing* habitat serves to maintain habitat quality and function, correct problems, minimize impacts, and provide benefits to species' and ecosystem recovery.

Management includes all land, environmental, and species management actions, from flood control to eradication of *invasive* species. Many *tidal marsh* areas, whether existing, restored, or in process of restoration, will need active management for some time to foster ecosystem functions and native species.

Habitat management must be conducted adaptively, consciously investigating and clarifying the effects of various management methods or environmental factors, and adjusting management accordingly. Adaptive management requires, and is linked with, monitoring of habitat or *population* response. Written adaptive management plans should be prepared for all *tidal marsh* areas under conservation management. Adaptive management plans help assure comprehensive attention to recovery needs, while allowing—even requiring—change to meet new needs or new understanding. Like restoration projects, management plans should describe purposes and goals and incorporate explicit, measurable success criteria.

Below are some strategies for common management of *tidal* marshes:

A major focus of *tidal marsh* management at least in the near term must be monitoring and controlling *invasive non-native* species, beginning with some that actually threaten the continued existence of the native *tidal marsh* ecosystem. *Non-native* smooth cordgrass, *Spartina alterniflora*, and its hybrids with native *S. foliosa*, now threaten to overwhelm San Francisco Bay Estuary *tidal*marshes within a decade or two—and could reach other California *tidal* marshes as well (Ayres and Strong 2002, Smith *et al.* 2002, May *et al.* 2003, Baye 2004*b*). See further discussion below on smooth cordgrass under the San Francisco Estuary regional recovery strategies. A variety of *non-native* cordgrass species present control problems in the San Francisco Bay Estuary, Bolinas Lagoon, Drakes Estero, Tomales Bay, Humboldt Bay, and elsewhere on the Pacific coast (Smith *et al.* 2002). Perennial pepperweed (*Lepidium latifolium*) and other *non-native*s also are affecting substantial areas of California *tidal marsh* and will require control (May *et al.* 2003).

Monitoring and control of *non-native* or artificially abundant predators that reduce survival or reproduction of rare or endangered native *marsh* species is another important element of *invasive* species control. Controlling *non-native* red fox predation on California clapper rails is one example, discussed further under regional recovery strategies for the San Francisco Estuary. Control techniques are evolving rapidly, so managers instituting control programs should consult the latest available information and contact personnel with recent field experience.

Other management issues include controlling water quantity and quality, dealing with contaminants of water or *sediments*, guiding recreation, coordinating with landfills on avian predator problems, managing grazing to limit destructive impacts and maximize potential benefits, and maintaining necessary roads, *levees* and other infrastructure.

Restoration—Some of the greatest gains in *tidal marsh* recovery will be made from *restoring* historic former *tidal marsh* or other restorable area to functioning *tidal marsh* habitat. Because so much historic *tidal marsh* has been altered or lost, and the resulting limitation and fragmentation of habitat continues to threaten species covered in this draft recovery plan, habitat restoration will allow and speed the recovery and conservation of *tidal marsh* species. *Tidal*

marsh restoration projects can be quite varied, from removing fill and planting native species at engineered elevations, to breaching a *levee* and allowing sedimentation and natural colonization to gradually re-build a *marsh*. Partial restoration of *tidal* action (rather than full *tidal* action) or controlled water levels also can sometimes achieve certain conservation objectives. Deeply subsided former *marsh* areas present particular problems, but some projects are proposed to restore them by bringing in *sediment* to reduce depths. Significant challenges in *tidal marsh* restoration will include keeping *non-native* species from invading areas intended for restoration, balancing *tidal marsh* restoration with other regional conservation needs, such as conservation of shorebirds and waterfowl, and planning for rising sea level. A great deal of information is available about *tidal marsh* restoration needs, methods, and projects (Philip Williams and Associates, Ltd. and Faber 2004).

Any *tidal marsh* restoration project should include measurable success criteria by which the project can be objectively evaluated. Accepted criteria for successful *tidal marsh* restoration need to be agreed upon by experts in the field, with these criteria being improved as new information becomes available. The Bay Institute, in 2004, published *Design Guidelines for Tidal Wetland Restoration in San Francisco Bay* which evaluates and documents actual restoration experience in San Francisco Bay (Philip Williams and Associates, Ltd. and Faber 2004). The document, which discusses objectives, constraints, design guidelines, and recommendations central to most *tidal marsh* restoration projects, should be consulted prior to *tidal marsh* restoration conducted per recommendation of this draft recovery plan. Though Philip Williams and Associates, Ltd. and Faber (2004) is the best guidance available now, it may be replaced with a better document during the life of this recovery plan. As data from current and future restoration projects add to the knowledge base and understanding, design guidelines will become more refined. It is clear that key elements of restoration include vegetation structure (height and thickness relative to *tide* height); channel structure; and high *tide refugia* and transitional areas.

Timing and sequencing of *tidal marsh* restoration needs to be considered from a biological and evolutionary viewpoint. For example, successful habitat for the southern subspecies of the salt *marsh* harvest mouse is dependent on the ability to: 1) create complete salt *marsh*es with broad upper *marsh* plains dominated by *Sarcocornia pacifica* that grade into *peripheral halophyte* (*i.e.*, high *marsh*) and upland habitats; 2) create these marshes to connect existing and restored salt marshes within and adjacent to the project area, and 3) create these restored marshes in close proximity to existing marshes that provide suitable salt marsh harvest mouse habitat. These nearby interim mouse refuges will be crucial for survival of *populations* while new adjacent habitat is maturing and becoming suitable.

The restoration of large blocks of *tidal marsh* has numerous advantages. For example, large marshes increase distances from upland predator den/nest sites and impede terrestrial predators. Large areas of *marsh* have fewer urban *edge effects*, including human-related disturbance, contaminant inputs, and litter that can attract rodent predators. In addition, the size and complexity of *tidal slough* networks increases as *marsh* size increases. Elevation increases in higher order *tidal sloughs*, providing more nesting areas and high *tide refugia*. Large-scale

restoration projects are also more efficient than smaller efforts, and yield larger net benefits to the species covered in this draft recovery plan.

Long-term recovery actions should focus on increasing habitat suitability and abundance in an appropriate distributional pattern. Important priorities for habitat restoration are those areas with the most rapid restoration potential relative to the amount of time and effort invested. Habitat restoration should first occur on suitable habitat near existing large *populations* and interim reserves, and then provide links between those areas. Areas in need of restoration but absent *non-native* species (especially *invasive Spartina* and *non-native* red fox) and areas least subsided may be considered first priority for restoration to *tidal marsh*, as well. Restored *tidal*marshes with core *populations* should coalesce with one another to form extensive, contiguous habitats in large blocks, thus reversing fragmentation of habitats and *populations*. This can be accomplished by either restoring very deep (from shore to bay) marshes or by creating deep enough marshes and also creating deep and gentle enough sloped high *marsh* that such areas could act as fully functional *corridors*.

New marshes should be connected to each other and/or to existing marshes to decrease the number of isolated marshes. Broad *corridors* of appropriate vegetation will provide stepping stones to allow species to colonize newly created marshes and move between marshes that are currently isolated. Dispersal facilitates exchange of *genetic* material among sub*populations* and promotes recolonization of any sites that experience declines or local extirpation.

While the mid-*marsh* should not be filled or over-engineered (because that results in marshes without complex channel structures), the high *marsh* must be engineered to have a more gradual slope in as many areas as possible. Transitional habitat used as high *tide refugia* can be created in the form of natural *berms* and *levees* along the larger channels within the middle *marsh*. Creating large marshes with complex channel systems provides sufficient drainage area to allow sedimentation to create natural *levees* along the larger channels. Philip Williams and Associates, Ltd. and Faber (2004) suggest that the technique of constructing starter channels and starter *levees*' does not work; they suggest the best way to get complex internal channel systems is by slow deposition that naturally creates such channels if the *marsh* is large and deep (from shore to bay) enough to support them.

Restoration of *tidal*marshes must include foundations for large high *marsh* belts, wide, gently-sloping gradients between mean higher high water and local elevations of storm high *tide* lines (*driftlines*). This design feature may accommodate a range of sea-level rise scenarios. In particular, preserved and restored marshes must whenever possible be connected to broad undeveloped, gently sloped adjacent terrestrial habitats. Marshes separated from shore by ponds or *levees* run the risk of being submerged by increased sea level, or prevented by erosion from accreting new *sediments* or maintaining *marsh* elevations. These *ecotones*, the transitional areas between habitats, are vital to some of the species covered in this draft recovery plan. There are a few locations where high *tidal marsh ecotone* can be restored in areas that adjoin existing grasslands. Such locations warrant extra consideration as they are prime areas for restoring the transitional or *peripheral halophyte* zones critical to the salt marsh harvest mouse and other species during high *tides*. Also, it is more imperative to restore *ecotone* habitat where there are constraints to the development of deep (from shore to bay) marshes versus shallow marshes.

Habitat Monitoring—Monitoring of habitat condition is an essential component of good habitat management, to assess whether restoration or management actions are working, and to detect undesirable or unexpected conditions. In general, monitoring should be conducted for multiple years and involve implementing standardized species and habitat surveys and assessments. Monitoring may be more intensive at first to obtain baseline information, to ensure that the objectives are being met, or if progressive change in the habitat is expected, such as following restoration work. The data recorded must be adequate to address the success criteria of the restoration or management plan. Monitoring should always include an assessment of the existing threats. If a protected area is surrounded by numerous threats, more frequent monitoring may be needed. If a location is highly protected (*i.e.,* strictly a preserve), then monitoring needs may not be as intensive. To be useful, habitat monitoring reports should be prepared promptly and made generally available to *tidal marsh* land managers and managing agencies, including the U.S. Fish and Wildlife Service.

Monitoring itself may have a negative effect on species and habitat if not carefully designed. This source of disturbance must be considered in the development of monitoring plans, together with other potential coinciding *marsh* activities (*e.g.*, *invasive* plant control, mosquito management, research).

3. Conduct range-wide species status surveys/monitoring and status reviews for listed species and species of concern covered in this draft recovery plan.

Species typically must increase in numbers of individuals, numbers of *populations* and/or geographic extent over the long term to achieve recovery. Declines or contractions in *populations* must be detected, halted, and reversed, if *populations* are to be self-sustaining. Species status surveys and monitoring allow us to follow such *population* trends. To delist a species, it must be determined that the species is no longer subject to the threats that caused it to be listed. Therefore, each threat a species faces also must be monitored to ensure recovery objectives and criteria are being met. Delisting will not be appropriate until the threats to *population* sustainability have been ameliorated or eliminated.

Monitoring is frequently conducted for known *populations*, yet the distribution and abundance of many of the species covered in this draft recovery plan are incompletely known. Therefore, range-wide *population* status surveys are needed, incorporating areas not recently studied, including areas where the species covered in this plan are not known to occur. Field surveys also will help to avoid or minimize impacts of projects proposing actions in or near potential habitat. Surveys should be conducted in all potential habitat types. Any new *populations* found may increase the speed and likelihood of recovery. Status surveys conducted for species not covered in this plan (**Table II-8**) will increase the understanding of these species, identify needs and threats, and help lead to actions that may preclude the need to list them as threatened or endangered.

Species status surveys and monitoring should follow appropriate U.S. Fish and Wildlife Service and/or State guidance whenever it is available. Specific information can be obtained from the U.S. Fish and Wildlife Service and California Department of Fish and Game. Biologists

monitoring certain species, such as salt marsh harvest mouse and California clapper rail, must obtain Endangered Species Act section 10(a)(1)(A) recovery permits as well as scientific collecting permits issued by California Department of Fish and Game.

Demographic monitoring, which includes trend analysis and determination of limiting factors (Pavlik 1994), is one method for predicting plant *population* trends and focusing efforts on the causes of *population* decline at a particular site. Animal species survey and monitoring requirements will vary depending on species, as well as site location, site conditions, and time of year. Status surveys and monitoring should always include assessment of the existing threats to the species.

Reports of survey and monitoring work should be completed promptly and made publicly available so that findings can be applied in all conservation and recovery efforts. In all cases, an attempt to quantify probability of detection is strongly recommended.

4. Conduct research necessary to the recovery of listed species and long-term conservation of species of concern covered in this draft recovery plan.

Research on many aspects of species' biology and *tidal marsh* ecology will help to meet recovery goals successfully and in a cost effective manner. Making recommendations on research needs and proposals will be a responsibility of the U.S. Fish and Wildlife Service and the Recovery Implementation Team (RIT), a group to be formed to implement this draftrecovery plan and discussed further below. Examples of research topics include *demographic* analyses of covered species or techniques for ecosystem management or restoration.

5. Improve coordination, participation, and outreach activities to achieve recovery of listed species and long-term conservation of species of concern covered in this draft recovery plan.

To most effectively implement the draft recovery plan, *tidal marsh* researchers, regulators, and managers must closely coordinate. As described further in the Stepdown Narrative below, a Recovery Implementation Team (RIT) will be developed which will include tiered regional or species-specific working groups. The purpose of the RIT will be to advise the Regional Director on matters associated with recovery of the species covered in this plan and to help the Regional Director coordinate, refine, and expedite recovery actions, including prioritization of research tasks. In addition to prioritizing and implementing technical recovery tasks, the RIT will be an outlet for effective public outreach and education.

Public participation is also vital to ecosystem recovery. One goal of the draft recovery plan is to coordinate and bring together landowners, both public and private, to achieve conservation and recovery needs and to form lasting partnerships. Because a substantial percentage of *tidal marsh* or restorable areas is under public ownership, working with public lands agencies to form beneficial relationships is key to the recovery strategy. Partnerships with private landowners are extremely important, because of the need to maximize *tidal marsh* area for recovery and to link fragmented *tidal* marshes with appropriate species dispersal *corridors* and *refugia*. Many private landowners, local agencies, organizations and citizens are willing participants in recovery efforts,

but they may not have the information necessary to make fully informed decisions. Outreach to develop working relationships with all interested parties is essential. Education will be a key component in increasing the public's general awareness of *tidal marsh* ecosystems and participation in *tidal marsh* restoration and recovery. Outreach and educational programs will be developed in cooperation with schools, agencies, conservation organizations, and stakeholder groups.

Age-appropriate educational materials should be prepared collaboratively by species experts and public educators, and distributed to (1) environmental journalists in the region, (2) public schools at all levels, and (3) undergraduate ecology programs at universities and colleges. Public outreach materials should avoid presentation of general priciples of biology and instead focus on clear audience-appropriate explanations of the principal threats to the species (with emphasis on local conservation issues), the rationale for recovery strategies and actions, and the results or progress of local recovery actions.

2. Regional-level recovery strategies

The general ecosystem strategies apply throughout the planning area, but there are regional differences that call for differing emphases or unique strategies in some areas. The level of detail is greatest for the San Francisco Bay Estuary, which has not only the greatest concentration and magnitude of endangered species recovery needs, but is the largest, most complex, and most altered of California's estuaries. A checklist of species to consider in recovery planning (species with and without special legal status) of estuaries in each region is below. These lists should not be considered exhaustive, however, and other sources and updates should be consulted to obtain complete lists, including a current species list from the appropriate U.S. Fish and Wildlife Service field office.

Humboldt Bay and north coast

Regional strategies for Humboldt Bay and the coast north from Bodega Bay focus on protection and restoration of *tidal marsh* habitat, particularly for sensitive plants. Though this area historically supported California clapper rail, no listed species covered by this draft recovery plan now exist within, or are anticipated to expand into this area. Therefore, no corresponding Recovery Unit for this area has been developed. Humboldt Bay, however, supports several sensitive *tidal marsh* species and many actions recommended in this draft recovery plan would benefit those species immensely. Further evaluation, planning, and funding are needed to advance *tidal marsh* conservation in the region. A checklist of species to consider in planning for the region is given in **Table III-4**. Please contact the U.S. Fish and Wildlife Service's Arcata Fish and Wildlife Office for an updated list.

Habitat should be secured to increase habitat and *populations* for *endemic* rare *marsh* plants. The Humboldt Bay National Wildlife Refuge is authorized to expand from the present approximately 3500 acres to about 9100 acres; however, there is considerable overlap between the authorized refuge area and tidelands under the authority of the Humboldt Bay Harbor

Recreation and Conservation District which does not specifically manage lands for rare plants. Currently the refuge has no large active acquisition projects. *Tidal* lands or potentially restorable tidelands for conservation should be identified, comprehensively reviewed and prioritized, and acquired from willing sellers. Existing fringing salt marshes should be protected against filling or dredging.

Table III-4. Regional Species Planning Checklist: Humboldt Bay and North Coast

Federally listed species:

Animals

western snowy plover (*Charadrius alexandrinus nivosus*)
tidewater goby (*Eucyclogobius newberryi*)
steelhead (*Onchorhynchus mykiss*)

Other species of regional conservation significance:

Animals

harbor seal (*Phoca vitulina*)
Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*)
shorebirds, wading birds, waterfowl (multiple species)

Plants

marsh locoweed (*Astragalus pycnostachyus* ssp. *pycnostachyus*)
northern salt marsh bird's-beak (*Cordylanthus maritimus* ssp. *palustris*)
Humboldt Bay owl's-clover, northern form (*Castilleja ambigua* ssp. *humboldtiensis*)
slim aster (*Aster subulatus* var. *ligulatus*)
salt marsh baccharis (*Baccharis douglasii*)
salt marsh edge sedges (*Carex* spp.)
sea-milkwort (*Glaux maritima*)
eelgrass (*Zostera marina*)

Local initiatives to restore native *tidal marsh* and to control *non-native* species (such as dense-flowered cordgrass) should be supported. *Tidal marsh* enhancement and restoration projects should prioritize areas that will benefit rare plant *populations*, such as *Castilleja ambigua* ssp. *humboldtiensis*, *Cordylanthus maritimus* ssp. *palustris*, *Astragalus pycnostachyus* var. *pycnostachyus*, and local *endemic* forms of the widespread *Grindelia stricta* var. *stricta* complex. Rare plant *populations* should be expanded in suitable habitat, both in restored and selected existing unoccupied marshes.

Diked baylands between the historic high *tide* line and Mad River Slough should be restored to full *tidal* action, allowing slow sedimentation to restore *tidal* salt *marsh* close to remnant *populations* of salt *marsh* plant species of concern. A wide, deep (from shore to bay) block of *tidal* salt *marsh* should be restored in *diked* baylands at the north end of Arcata Bay, adjacent to wide *tidal* flats that buffer erosion and supply some local *sediment* source. Placement of suitable

dredged *sediments* or fill from excavated, former *marsh* areas may be needed here to supplement the landward edge of the restored *marsh* and to enable marshes to keep pace with sea level rise. In fact, a *tidal* restoration project is currently being conducted at McDaniel Slough (Pickart, *in litt.* 2009). Local in-bay *tidal* marshes at Field's Landing and Elk River Spit should be periodically surveyed and protected. Restoration at Salmon Creek may result in restoration of *diked* baylands at the south end of Arcata Bay to *tidal* action adjacent to wide *tidal* flats. *Tidal* flats in the South Bay should be studied to forecast the potential for natural *accretion* to elevations supporting pioneer salt *marsh* succession. Opportunities for *tidal marsh* restoration in the *tidal* reaches associated with the Eel River mouth, just south of Humboldt Bay, should be explored and pursued. All existing and current restoration projects should be extensively monitored and adaptively managed to inform future restoration projects.

Dense-flowered cordgrass should be eradicated from Humboldt Bay, Eel River, and Mad River estuaries. Methods for mechanical eradication have been developed at Humboldt Bay National Wildlife Refuge, and an effort is underway, pursuant to the West Coast Governor's Agreement, to develop a regional eradication plan. Localized control is not feasible due to tidally dispersed seeds. Communication and cooperation with the San Francisco Bay invasive *Spartina* control project should aid both cordgrass control efforts.

Potential habitat for rare plants should be mapped and comprehensively surveyed. Ongoing monitoring of rare plant *populations* should be established. Relict salt marshes with native plant species of concern, particularly Indian Island—in collaboration with the Table Bluff Reservation Wiyot people and the Humboldt Bay NWR—should be periodically surveyed and protected.

Special consideration should be given to small pockets of *tidal marsh* along the coast in areas between Bodega and the Eel River estuary, such as along *tidal* reaches near the mouths of coastal rivers or creeks or around small *tidal lagoons* or *sloughs*. Examples of such *tidal* reaches include Big River, Tenmile River, and Mattole Creek. Such areas may serve as resting or even breeding areas for dispersing birds like California black rails or California clapper rails, and many need to be surveyed for rare or *endemic* plant *populations*.

***SAN FRANCISCO BAY ESTUARY*:**

The San Francisco Bay Estuary as a whole encompasses Central/Southern San Francisco Bay, San Pablo Bay, and Suisun Bay Area Recovery Units. Specific sub-regional strategies are discussed in separate sections below. The following general strategies apply throughout the San Francisco Bay Estuary:

Protect remaining tidal marsh and tidal flats. *Tidal marsh* in the San Francisco Bay Estuary has been severely reduced and what remains is valuable for recovery of species included here. Historical *tidal marsh* remnants are particularly important (pre-existing, as opposed to recently formed *marsh*). However, these protective principles need to be flexible where restoration-focused projects would affect small *marsh* areas to restore much larger areas.

Tidal flats are valuable habitat for water birds, fish, mollusks and other species. They provide substrate and a source of *sediment* for *tidal* restoration and also are important in reducing wave

energy and erosion. *Tidal* flats are essential to *tidal marsh* maintenance, since without *tidal* flats many marshes would erode and lose substantial area. Dredging, filling, or other direct modification of *tidal* flats should be severely discouraged.

Restore tidal marsh. Recovery of *tidal marsh* species will be fostered through significant amounts of *tidal marsh* restoration. Placement of suitable dredged *sediments* or fill from excavated, former *marsh* areas may be needed to supplement the landward edge of the restored *marsh* and to enable *marsh*es to keep pace with sea level rise. Restoration strategies in the *estuary* should build on the following principles:

1) Restore *tidalmarsh* ecosystems around nuclei of existing listed species *populations*;
2) Phase restorations to minimize local *population* impacts and maintain local source *populations*;
3) Restore large contiguous areas;
4) Restore functional connectivity between species *populations* with low mobility;
5) Seek extensive *marsh* creek development, pickleweed plains, high *marsh halophyte* zones, *marsh*-to-terrestrial *ecotones*, broad connection to adjacent *uplands*, and, where appropriate, natural *salt pans* and shallow ponded *tidal*habitat;
6) Seek buffers from developed areas;
7) Remove *dikes* and other habitat and movement *corridors* for terrestrial predators, where feasible;
8) Remove above ground poles, towers, and habitat-inappropriate trees to reduce raptor perches;
9) Accommodate a range of sea level rise scenarios, ideally with long, gentle gradients;
10) Plan and provide funding for long-term monitoring and adaptive management, including *invasive* plant control and predator control.

Predator control. Controlling local *populations* of *non-native* or artificially abundant predators will be an important recovery strategy for *tidal marsh* birds and mammals throughout the *estuary*. California clapper rails are well known to be decimated by predation from a variety of species, as discussed above in the California clapper rail species account (see Reasons for Decline and Threats to Survival).

To date the only effective methods for eliminating red fox involve limiting fox access to the *marsh*, trapping, and shooting by trained animal control specialists. In addition, denning habitat for foxes should be removed. Similar control techniques are applicable to other mammalian predators. These techniques should be applied, as appropriate, to thoroughly protect rail *populations*, and more effective methods should be investigated.

Predator control necessitates a public education component, as well. Numerous actions can be undertaken by local homeowners or visitors to the *marsh* to reduce the impact of predators on listed species. Feeding of feral cats should be prohibited, illicit feeding stations located and removed, and homeowners adjacent to *tidal* marshlands should be notified that cat trapping may be conducted to protect endangered species. In addition, where new housing developments are planned, cat-proof fences and other means should be employed, and funds to conduct predator management should be leveraged by homeowners groups.

Norway rats should be controlled by eliminating their nest habitat and attractive food sources (garbage, etc.) when practical, and by trapping or using bait stations in other areas. Rock slope protection (rip-rap) which provides rat habitat can productively be replaced with low-angle slopes vegetated with erosion-resistant native plants like *Leymus triticoides* (creeping wildrye) and *Distichlis spicata* (saltgrass). Vehicular barriers can be used to restrict illicit waste dumping near *tidal marsh* habitat; and buffer zones can separate main rat *populations* from the *marsh*. In addition, conducting trapping of target mammalian species near landfills and other food sources will help prevent these animals from dispersing to nearby *marsh* areas.

A potentially effective means of controlling terrestrial predators, but one likely to take time to implement fully, is to restore large marshes with no internal *dike* access. Terrestrial predators are less likely to venture deep into *undiked marsh*, so habitats in large continuous marshes are protected from serious predator impacts. Restoring high *tide* refugial habitat that is isolated from *dikes* within large marshes might enhance this protection.

Avian predators are also important predators of *tidal marsh* birds and mammals, as discussed above in Chapter II in the California clapper rail species account. Landfills and urban areas provide food resources that would otherwise not be available, while buildings, towers, and other human-made structures provide nesting and roosting opportunities. To reduce predation levels, artificial food resources should be reduced and perches such as light poles, utility poles and towers, and habitat-inappropriate trees should be removed from marshes. When this is impractical, land managers should conduct local control of target avian species and should discourage nesting of these species in and near marshlands whenever possible. For instance, red-tailed hawk and raven stick nests could be removed from electrical transmission and distribution lines, with cooperation of utilities companies. Removal of nests must be done in accordance with the Migratory Bird Treaty Act of 1918.

Public use. Public use is important to *tidal marsh* appreciation and should be encouraged. However, public use should be designed with careful consideration of accompanying risks and impacts to *tidal marsh* species. Generally, public use should be guided to relatively few, lower impact areas. Visual access should be enhanced over physical access by providing viewing stands but minimizing trails into *marsh* habitat. Any shoreline trails considered essential and low-impact should be routed well away from high *tide* edge and high *tide* refugial habitat. Discretion should be retained to restrict or close access to minimize impacts, such as during California clapper rail breeding season or extreme high *tides*. Pets should be excluded and feeding of feral animals prohibited.

Flood control. *Dikes* that protect development from bay flooding (flood control *dikes*) should be relocated to the development edge. Where development abuts *tidal marsh* and the *dike* effectively will be high *tide* refuge and upland *ecotone* for *tidal marsh* species, flood control *dikes* (inboard *levees*) should ideally have long, gentle slopes (*e.g.,* 1:20 or less) from *marsh* toe to *levee* crown and be vegetated with appropriate native species. Flood control *dikes* should be planned to accommodate a range of sea level rise scenarios. *Tidal* flats, marshes, and salt ponds or *lagoons* all act to dissipate the energy of flood *surges*, and these habitats should be encouraged outboard of flood control *dikes* to increase protection. Flood control *dikes* that are

currently at the bayward perimeter of salt ponds or *diked* baylands should be graded to *marsh* elevations, or removed, consistent with restoration plans.

Remove dikes, utility lines, pipes, old right-of-ways. Existing infrastructure in baylands can present substantial obstacles to high-quality *tidal marsh* restoration. *Dikes* provide predator habitat and access deep into *tidal*marshes, fragment *marsh* area, and block *tidal* flows and drainage. In general they should be removed or graded down to *marsh* elevations. Utility lines and pipelines (and any *dike* access roads that serve them) should be removed, re-routed or maintained by other access, such as boat, helicopter, hovercraft, track vehicle, or access across temporary mats. Consideration may be given to undergrounding utility lines, perhaps through mechanisms such as section 7 or section 10(a)(1)(B) of the Act.

Research. A great deal of research is needed to help us better understand how to recover the species of the San Francisco Bay Estuary. The Recovery Implementation Team (RIT) will advise the U.S. Fish and Wildlife Service on updated topics and priorities for study. Through an adaptive management framework, results of these studies will be applied to better manage for this draft recovery plan's covered species. Research is currently needed on the effects of San Francisco Bay contaminants (*e.g.,* petroleum compounds, pesticides, metals) as well as how to ameliorate any effects of contaminants. Another example of needed research is research on more effective and cost-effective means of control of *invasive* plants and animals. Further research tasks that are presently identifiable are mentioned in recovery strategies below, and outlined in the Stepdown Narrative section.

Suisun Bay Area to the Delta

This discussion involves Carquinez Strait (east of the Carquinez [I-80] Bridge), Suisun Bay, Honker Bay, Grizzly Bay, Suisun Marsh, the Contra Costa shoreline east of Carquinez Strait, and portions of the Sacramento-San Joaquin River delta (**Figure III-2**), though the Recovery Unit of the same name does not extend to portions of the Sacramento-San Joaquin River delta. With rising sea level, it is anticipated that areas important to the recovery and conservation of *tidal marsh* species will extend upstream into present-day *brackish* to *freshwater* areas including parts of the Delta. A sample regional species planning checklist for the Suisun Bay area is given in **Table III-5**.

Table III-5. Regional Species Planning Checklist: Suisun Bay area to the delta

Federally listed species:

Animals

salt marsh harvest mouse (*Reithrodontomys raviventris halicoetes*)
California clapper rail (*Rallus longirostris obsoletus*)
California least tern (*Sterna antillarum browni*)
western snowy plover (*Charadrius alexandrinus nivosus*)
California tiger salamander (*Ambystoma californiense*)
California red-legged frog (*Rana aurora draytonii*)

steelhead (*Onchorhynchus mykiss*)
chinook salmon (*Oncorhynchus tshawytscha*)
Delta smelt (*Hypomesus transpacificus*)
Delta green ground beetle (*Elaphrus viridis*)
vernal pool tadpole shrimp (*Lepidurus packardi*)
vernal pool fairy shrimp (*Branchinecta lynchi*)
white sturgeon (*Acipenser transmontanus)*

Plants

Cirsium hydrophilum var. *hydrophilum* (Suisun thistle)
Cordylanthus mollis ssp. *mollis* (soft bird's-beak)
Lasthenia conjugens (Contra Costa goldfields)

Non-listed species covered by this draft recovery plan:

Animals

Suisun shrew (*Sorex ornatus sinuosis*)
California black rail (*Laterallus jamaicensis coturniculus*)
saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*)
Suisun song sparrow (*Melospiza melodia maxillaris*)
old man tiger beetle (*Cicindela senilis senilis*)

Plants

Lathyrus jepsonii var. *jepsonii* (Delta tule pea)
Spartina foliosa (California cordgrass)

Other species of regional conservation significance:

Animals

North American river otter (*Lutra canadensis*)
Virginia rail (*Rallus limicola*)
sora (*Porzana carolina*)
Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*)
peregrine falcon (*Falco peregrinus*)
migratory waterfowl, shorebirds, wading birds (multiple species)
western pond turtle (*Clemmys marmorata*)
California red-legged frog (*Rana aurora draytonii*)
green sturgeon (*Acipenser medirostris*)
longfin smelt (*Spirinchus thaleichthys*)
Sacramento splittail (*Pogonichthys macrolepidotus*)
Pacific lamprey (*Lampetra tridentata*)
river lamprey (*Lampetra ayresi*)
Antioch anthicid beetle (*Anthicus antiochensis*)
Sacramento anthicid beetle (*Anthicus sacramento*)

Plants

Agrostis exarata, Leymus triticoides, tidal marsh edge populations (salt marsh edge grasses)
Aster lentus, A. chilensis and intergrades (Suisun and Chilean aster complex)
Astragalus tener ssp. *tener* (alkali milk-vetch)
Aster subulatus var. *ligulatus* (slim aster)
Atriplex joachiniana (San Joaquin saltbush)
Baccharis douglasii (salt marsh baccharis)
Carex spp. (salt marsh edge sedges)
Castilleja ambigua ssp. *ambigua* (salt marsh owl's-clover)
Centaurium trichanthum (alkali centaury)
Cicuta maculata var. *bolanderi* (Bolander's spotted water-hemlock)
Lasthenia glabrata ssp. *glabrata* (smooth goldfields)
Downingia pulchella (downingia)
Eleocharis parvula (small spikerush)
Glaux maritima (sea-milkwort*)*
Grindelia paludosa (Suisun gumplant)
Heliotropium curassavicum (seaside heliotrope)
Hemizonia pungens ssp*. maritima* (maritime spikeweed)
Iva axillaris var. *robustior* (povertyweed)
Lasthenia platycarpha (alkali goldfields)
Layia chrysanthemoides (smooth tidytips)
Lepidium latipes (native peppercress)
Lilaeopsis masonii (Mason's lilaeopsis)
Plagiobothrys mollis var. *vestitus* (Petaluma popcornflower)
Plantago elongata (annual coast plantain)
Pluchea odorata (salt marsh fleabane)
Ruppia maritima (ruppia)
Senecio hydrophilus (salt marsh butterweed)
Sium suave (water parsnip)

Restoration of *tidal marsh* will be a major recovery strategy in this region. Integrating restoration with appropriate habitat support for the migratory waterbirds of the Pacific flyway will be essential because of the great significance of the region for migratory waterfowl. In addition, substantial weight will be given to *tidal marsh* restoration to support the conservation and recovery of special status estuarine fish species (Delta smelt, white sturgeon, Sacramento splittail). These species use *tidal marsh* habitat, particularly vegetated banks of *brackish tidal* creeks during low *salinity* phases.

Restoration of *tidal marsh* creek habitat near the *null zone* (zone of no current and highest *sediment* deposition) of Suisun Bay and Honker Bay is a priority for recovery of estuarine fishes as well as a benefit to *tidal marsh* species. Morrow Island, western Grizzly Island, Simmons Island, Wheeler Island, Chipps Island, and Van Sickle Island are in favorable receptive positions for *tidal* sedimentation as well as flood deposition from the Sacramento and San Joaquin rivers, and as such may be good candidates for rapid establishment of *tidal marsh* habitats. The

positional advantages of *tidal marsh* restoration in eastern Suisun Bay/Honker Bay sites, adjacent to the productive *null zone* of the *estuary*, raise their potential recovery value for estuarine fish, and may provide good habitat for rare plants like *Lilaeopsis masonii* (Mason's lilaeopsis), and endangered plants like *Cordylanthus mollis* ssp. *mollis* and *Cirsium hydrophilum* var. *hydrophilum.*

At present, the Suisun Bay area supports about 7,625 acres of *tidal marsh* out of an historical extent of roughly 65,000 acres (Estrella *in litt*. 2007). Based on all species habitat, connectivity, and ecosystem needs, it is anticipated that restoration will bring the total *tidal marsh* acreage in Suisun Bay area to a total of between 10,000 and 15,000 acres. Precedence should be given to restoring sites that would expand habitat adjacent to significant *populations* of listed species. Sites that include a gradual transition from high *marsh* to terrestrial areas also are important—not only to provide ecotonal habitat but also to allow *marsh* habitats to migrate up-gradient with rising sea level. Other priorities for restoration include sites that connect other *tidal* or restoration areas, sites that provide important ecosystem functions, and sites that otherwise support the recovery strategies of this draft recovery plan.

Since there is relatively less adjacent development, the Suisun Bay area offers greater opportunities than most San Francisco Bay Estuary areas for preserving and restoring natural transitions from *tidal marsh* to adjacent upland habitats. Unique *tidalmarsh-vernal pool* grassland transitions with gentle gradients occur in the areas around Hill Slough, Nurse Slough, and Montezuma. These areas are especially deserving of attention for protection and restoration. In Nurse Slough, fresh-*brackish* gradients created by Denverton Creek may provide low-*salinity refugia* for breeding delta smelt. Such drainages also provide potential for *riparian* habitat restoration near stream mouths, which would enhance ecotonal habitat diversity for species such as saltmarsh common yellowthroats. The area between Cordelia Slough and Peytonia Slough also may merit further restoration consideration.

Many *diked* areas of Suisun Marsh have subsided, so the initial phases of *tidalmarsh* restoration in deeper areas would create shallow sub*tidal lagoons* deeper than dabbling ducks would select. *Sediment* supply is less in Suisun Bay than in south San Francisco Bay, restricted by irregular flood flows and dams in the watershed. If *marsh accretion* is sediment-limited, such *lagoons* would be slow (years or decades) to achieve habitat values for dabbling ducks. Unassisted re-establishment of natural shallow "*marsh* ponds" attractive to dabbling ducks (*tidal pans* in mature *brackish marsh*) may take decades, or may even fail under accelerated sea level rise. These risks may require more careful site selection (*e.g.,* less-subsided sites) or engineering (*e.g.,* contouring) to ensure continuity of habitat support for both *tidal marsh* and waterfowl species and established land uses.

A potential restoration technique includes creation of "*microtidal*" or "muted" *lagoons* and *marsh*, which have some characteristics intermediate between non-*tidal*managed ponds and fully *tidal*restoration (approximating the "circulating ponds" of George *et al.* 1965). *Microtidal* areas have restricted *tidal*circulation, admitting *tides* only above a certain height or restricting the amount of water entering and leaving, or both. Unlike non-*tidal*management, they usually remain open to this limited *tidal* exchange, so some circulation is maintained, and excessive evaporative concentration of salts can be avoided. Because it impounds water, *microtidal*

restoration typically supports ponded areas, and can provide waterfowl habitat. *Microtidal* areas need not be impervious to extreme high *tides*, so low-elevation, low-gradient *dikes* or *berms* subject to occasional overtopping may be acceptable and provide high *marsh* habitat. With *tidal sediment* input and essentially continuous ponding, *subsidence* would be minimized. *Salinity* in *microtidal* areas in Suisun Bay would tend to vary seasonally, with salinities low into the late spring—due to water retention from rainfall input and low *salinity* winter spring *tide*s during the season of elevated *freshwater* inputs—and ranging to somewhat more saline than open *tidal* waters in the late summer and fall if concentration by evaporation exceeds the limited *tidal* circulation. Although a common objective of *microtidal* restoration would be to minimize active management, some ability to manipulate *salinity* could be designed into particular projects (*e.g.,* gates to admit larger amounts of less saline water) so that adaptive management is possible. Engineering fixes to prevent subsided areas from ponding too deeply also may be feasible.

Restoring *tidal* flows to former *diked* baylands in Suisun Marsh is likely to increase the volume of *tidal* water (*tidal prism*) exchanged in the area. How much *tidal prism* would change would depend on the total volume of *diked* baylands restored to *tidal* flows, constraints on *tidal* flow, and the rate of *accretion*. *Accretion* of *sediment* and organic matter raises the bed elevations of restored baylands, reducing *tidal prism* as *lagoons*, flats, creeks and marshes become shallower. Since sedimentation rate is often proportional to water depth, *tidal prism* would be expected to increase initially, then diminish as *mudflats* and finally *tidal* marshes accrete. *Tidal prism* is one of several factors that affect *salinity* in the Suisun Bay area. *Freshwater* outflow from the Delta exerts the greatest control on *salinity*, but during years of low outflows (drought conditions), increased *tidal prism* associated with extensive *tidal* restoration could increase salinities in Suisun Marsh, according to preliminary *hydrologic* modeling (Suisun Marsh Levee Investigation Team 2000). Improved *hydrologic* modeling is needed to help plan *tidal*restoration that has minimal impacts on *salinity* during sensitive drought years. *Tidal* restoration should be phased and monitored in response to any regional changes in *tidal prism* and *salinity*.

Planning for *tidal marsh* restoration in the Suisun Bay area should proceed promptly, including decision-making about any *dikes* that can be breached without extensive site preparation, or *dikes* that can be allowed to decline while focusing maintenance dollars on *dikes* with priority for long-term waterfowl management.

Several major restoration projects have begun in the Suisun Bay area: the Montezuma Wetlands project, which would provide a dredge spoil site and use the *sediments* to increase sub-*tidal* elevations for *tidal marsh* restoration. The site covers roughly 2,100 acres, including 340 upland and transitional acres, east of Montezuma Slough in the vicinity of Montezuma. In addition, in fall of 2006, a *levee* was breached near Little Honker Bay to restore *tidal* action to the Blacklock parcel, a 70 acre formerly managed wetland property. Currently, the project is in the monitoring phase. A 10-year program to monitor the physical and biological response to the restoration has been developed. Thirdly, the Department of Water Resources plans to tidally restore a 660 acre parcel at Meins Landing and is currently in the project planning phase. Restoration is slated to begin in 2010. Finally, *tidal* restoration is slated to occur on California Department of Fish and Game's 220 acre Hill Slough West parcel in approximately 2010.

High priority next steps in restoring *tidal* habitats in the Suisun Bay area include the following:

1. Expanded *tidal marsh* around Rush Ranch and Hill Slough, to reinforce the core area for listed *tidal marsh* species in Suisun Marsh;
2. A large, continuous block of restored *tidal marsh* at Morrow Island (Goodyear Slough), the westernmost and more saline *marsh*, with good potential for increased clapper rail use, and potential linkage for vagrant rails moving between San Pablo Bay and the Suisun Bay area;
3. A *corridor* of *tidal marsh* linking restored Morrow Island *tidal marsh* with the remnant and restored *tidal* marshes of Rush Ranch and Hill Slough areas;
4. Restoration of *tidal marsh* around Potrero Hills, Nurse Slough, and Denverton, to re-establish *ecotones* between *vernal pool* grassland ecosystems and *tidal marsh* (benefits for *Cordylanthus mollis* ssp. *mollis*, tolerance of sea level rise, and Delta fish);
5. Restoration or enhancement of large blocks of *tidal marsh* habitats along the Contra Costa shoreline, centered around *populations* of *Cordylanthus mollis* ssp. *mollis* and salt *marsh* harvest mouse; and
6. Restoration of *tidal marsh* near the *null zone* (bayfront *tidal marsh* extending from Ryer Island to Browns Island: Simmonds, Wheeler, Van Sickle, Chipps Islands, and Montezuma Wetlands converted to *tidal marsh*), with benefits for fish and other species.

Adapting and optimizing *management* of *tidal marsh* in the Suisun Bay area will be a second significant recovery strategy in the region. Historical *tidal* marshes, such as at Hill Slough and Rush Ranch, should be protected and maintained as closely as possible to their natural conditions. Control of *invasive non-native* plants such as *Lepidium latifolium* is a pressing management need, especially wherever they threaten remaining *populations* of endangered plants or the integrity of existing preserves, such as Hill Slough, Rush Ranch, or Benicia State Recreation Area (Southampton marsh). The *non-native Spartina patens* should be eliminated from Southampton Bay and any other Suisun Bay area locations. *Non-native* predators such as *non-native* red fox should be monitored and their impacts assessed and controlled as needed, particularly in areas important to California clapper rail and California black rail. Monitoring and control of *non-native* species also should be a universal element of *tidal*restoration projects. Land management practices, including *dike* maintenance, should be adapted to discourage *non-native* species. Unnecessary *dikes* should be removed or graded down to high *marsh* elevation to impede predator access to *marsh* habitat and to enhance *tidal*circulation and *marsh* creek development. Limited feral hog hunting has been allowed in portions of Suisun Marsh but a regional-scale eradication effort should be coordinated with California Department of Fish and Game to decrease the species' impact on habitat for sensitive plants. Appropriate grazing practices should be implemented, including minimizing damage to vegetation and banks along *tidal* creeks.

Salinity management practices using the Montezuma *salinity* control gates should be re-evaluated, along the lines recommended by the Brackish Marsh Subcommittee of the Suisun Ecological Workgroup (Suisun Ecological Workgroup 2001). Analysis indicates the gate operations result in salinities lower than pre-diversion conditions during the fall; while upstream water diversions result in salinities somewhat higher than pre-diversion conditions during the spring, when the gates are not operated (C. Enright pers. comm. 2005). Allowing greater *tidal*

range and more variable salinities would improve conditions for rare native *marsh* plants, among other species (see recovery strategies for *Cirsium hydrophilum* var. *hydrophilum* and *Cordylanthus mollis* ssp. *mollis*).

Management and habitat monitoring programs should be developed and implemented for *tidal marsh* conservation in the Suisun Bay area. These programs and associated plans should have provisions for adaptation to new information or changed circumstances. Habitat monitoring should be appropriate to identify management needs, including *invasive* species control problems and changes in habitat extent or quality.

Protecting additional *tidal marsh* or *tidal marsh* restoration areas will be a third significant recovery strategy in the Suisun Bay area, in addition to restoration and management. When opportunities exist, additional area should be protected under public ownership or easement. Areas that support listed plants, support recovery strategies for listed animals, support non-listed species covered by this draft recovery plan, connect existing preserves, or provide needed functions will be of interest. At the time of preparation of this draft recovery plan, roughly 17,000 *tidal* or formerly *tidal* acres are in public-trust ownership in the Suisun Bay area, mostly by California Department of Fish and Game (Bay Area Open Space Council online data). Much of this has historically been managed for migratory waterfowl.

The species recovery and conservation strategies for the Suisun Bay area emphasize *endemic tidal* species of the North Bay: *Cirsium hydrophilum* var. *hydrophilum*, *endemic* to Suisun Marsh, and *Cordylanthus mollis* ssp. *mollis*, which is centered in Suisun Marsh and Contra Costa shoreline *tidal* marshes. The Suisun *population* of California clapper rails currently is concentrated in the more saline reaches of western Suisun Marsh, and the species reaches the limit of its range in the northern San Francisco Bay Estuary as it tapers off toward the east. The range limits of the clapper rail may shift eastward in the Suisun Bay area as sea level rises, and *tidal marsh* ecosystem recovery in this region must anticipate this trend.

The salt marsh harvest mouse naturally ranges to the eastern edge of Suisun Marsh, but its modern abundance and distribution in Suisun Marsh is strongly affected by artificial *diked* conditions of doubtful long-term sustainability. Before widespread diking of Suisun Marsh and development of pickleweed flats, the mouse's natural *population* density in diverse *brackish tidal marsh* probably was lower. The strategy for the northern subspecies of the salt marsh harvest mouse in San Pablo Bay and the Suisun Bay area is to transition the *populations* from reliance on artificially managed, unstable habitat to larger, more secure, more widespread *populations* in restored *tidal marsh* ecosystems. This strategy also is more consistent with a multi-species, natural ecosystem restoration philosophy. Projects with direct, indirect, and/or cumulative impacts to habitat of the northern subspecies of the salt marsh harvest mouse should offset their impacts in a manner consistent with and supporting this transition.

In the meantime, the conservation areas set aside for salt marsh harvest mouse on Grizzly Island Wildlife Area will provide source *populations* for restored *tidal marsh* habitat within the Grizzly Island marsh Complex. *Diked* wetlands in the Wildlife Area will also provide long-term habitat protection for the species if the *dikes* are maintained and are not subjected to *catastrophic* flooding. These conservation areas, as well as the *diked* managed wetlands on public and private

land in Suisun Marsh will provide *refugia* for salt marsh harvest mice until restored *tidal marsh*es provide additional habitat.

The Suisun Marsh Charter Group has long been evaluating the balance of restoration, management and protection in Suisun Marsh. The Charter Group is a collaboration formed in 2001 to resolve issues of amending the Suisun Marsh Preservation Agreement (SMPA), obtain a Regional General Permit, implement the Suisun Marsh Levee Program, and recover endangered species. The Charter Group was charged with developing a regional implementation plan that would outline the actions needed in Suisun Marsh to preserve and enhance managed *seasonal wetlands*, restore *tidal marsh* habitat, implement a comprehensive *levee* protection/improvement program, and protect ecosystem and drinking water quality. The *Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh* would be consistent with the goals and objectives of the Bay-Delta Program, and balance them with SMPA, Federal and State Endangered Species Acts, and other management and restoration programs within the Suisun Marsh in a manner responsive to the concerns of all stakeholders, and based upon voluntary participation by private landowners. The proposed *Habitat Management, Preservation, and Restoration Plan for the Suisun Marsh* also would provide for simultaneous protections and enhancement of: (1) the Pacific Flyway and existing wildlife values in managed wetlands, (2) endangered species, (3) *tidal* marshes and other ecosystems, and (4) water quality, including, but not limited to, the maintenance and improvement of *levees*.

Surveys for *Cordylanthus mollis* ssp. *mollis* and *Cirsium hydrophilum* var. *hydrophilum* are needed in Suisun Marsh. In addition, surveys for sensitive, though not federally listed species, such as Suisun shrew and salt marsh wandering shrew should also be conducted.

San Pablo Bay

This discussion involves areas west of the Carquinez bridge and continuing south to a line between Pinole Point (Contra Costa County) and Point San Pedro (Marin County) on both sides of San Pablo Bay (**Figure III-3**), completely overlapping the Recovery Unit with the same name. Restoration and habitat acquisition projects should be the focus in this area, with consistent attention being given to controlling *invasive Spartina* and *Lepidium latifolium*.

Table III-6. Regional Species Planning Checklist: San Pablo Bay

Federally listed species:

Animals

California clapper rail (*Rallus longirostris obsoletus*)
salt marsh harvest mouse, northern subspecies (*Reithrodontomys raviventris halicoetes*)
western snowy plover (*Charadrius alexandrinus nivosus*)
California tiger salamander (*Ambystoma californiense*)
California red-legged frog (*Rana aurora draytonii*)
tidewater goby (*Eucyclogobius newberryi*)
steelhead (*Onchorhynchus mykiss*)

chinook salmon (*Oncorhynchus tshawytscha*)
Delta smelt (*Hypomesus transpacificus*)

Plants

Lasthenia conjugens (Contra Costa goldfields)
Cordylanthus mollis ssp. *mollis* (soft bird's-beak)
Suaeda californica (California sea-blite)

Non-listed species covered by this draft recovery plan:

Animals

Suisun shrew (*Sorex ornatus sinuosis*)
California black rail (*Laterallus jamaicensis coturniculatus*)
salt marsh common yellowthroat (*Geothlypis trichas sinuosa*)
San Pablo song sparrow (*Melospiza melodia samuelis*)
old man tiger beetle (*Cicindela senilis senilis*)

Plants

Spartina foliosa (California cordgrass)

Other species of regional conservation significance:

Animals

North American river otter (*Lutra canadensis*)
harbor seal (*Phoca vitulina*)
California sea-lion (*Zalophus californicus*)
Virginia rail (*Rallus limicola*)
sora (*Porzana carolina*)
Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*)
shorebirds, wading birds, waterfowl (multiple species)
western pond turtle (*Clemmys marmorata*)
green sturgeon (*Acipenser medirostris*)
longfin smelt (*Spirinchus thaleichthys*)
Sacramento splittail (*Pogonichthys macrolepidotus*)
San Francisco forktail damselfly (*Ishnura gemina*)
tiger beetles (*Cicindela* spp.)
western tanarthrus beetle (*Tanarthrus occidentalis* Chandler)

Plants

Astragalus tener ssp. *tener* (alkali milk-vetch)
Cordylanthus maritimus ssp. *palustris* (northern salt marsh bird's-beak)
Agrostis exarata, Leymus triticoides, Puccinelia nutkaensis (salt marsh edge grasses)
Aster lentus, A. chilensis and intergrades (salt marsh asters)
Aster subulatus var. *ligulatus* (slim aster)
Baccharis douglasii (salt marsh baccharis)
Carex spp.(salt marsh edge sedges)

Castilleja ambigua ssp. *ambigua* (salt marsh owl's-clover)
Centaurium trichanthum (alkali centaury)
Cicuta maculata var. *bolanderi* (Bolander's spotted water-hemlock)
Glaux maritima (sea-milkwort)
Heliotropium curassavicum (seaside heliotrope)
Hemizonia pungens ssp. *maritima* (maritime spikeweed)
Iva axillaris var. *robustior* (povertyweed)
Juncus spp. (perennial and *annual* rushes)
Lasthenia glabrata ssp. *glabrata* (smooth goldfields)
Lasthenia platycarpha (alkali goldfields)
Lepidium oxycarpum, *L. nitidum*, *L. latipes* (native annual peppercresses)
Lilaeopsis masonii (Mason's lilaeopsis)
Plagiobothrys mollis var. *vestitus* (Petaluma popcornflower)
Plantago elongata (annual coast plantain)
Polygonum marinense (Marin knotweed)
Ruppia maritima (ruppia)
Senecio hydrophilus (salt marsh butterweed)
Trifolium depauperatum var. *hydrophilum* (salt marsh cow-clover)
Zostera marina (eelgrass)

Tidal marsh species recovery in San Pablo Bay is moving forward at an encouraging pace, with tens of thousands of acres of preservation and restoration in place or planned. The U.S. Fish and Wildlife Service's San Pablo Bay National Wildlife Refuge and California Department of Fish and Game (notably at Napa-Sonoma Marshes, San Pablo Bay Wildlife Area, and Petaluma Marsh Wildlife Area) manage significant *tidal* and restorable lands. Numerous other conservation projects and proponents may be reviewed at a website created by San Francisco Estuary Institute (SFEI), Wetlands and Water Resources, and PRBO-Conservation Science: www.wetlandtracker.org. Rapid sedimentation and/or *tidal marsh* development in several less-engineered instances (Napa Marsh Pond 2A, Carl's Marsh, West End duck club, Port Sonoma Marina, Tubbs Island Levee Setback) indicate a highly favorable physical and biological environment for restoration in many areas.

Prompt implementation of *tidal* restoration projects is appropriate—compatible with the ecosystem and San Francisco Bay Estuary strategies above and additional recovery strategies below. Without prejudging particular restoration proposals, priority restoration areas appear as follows:

- Napa-Sonoma salt ponds, in particular ponds near the mouth of the Napa River or San Pablo Bay, and therefore close to major *sediment* sources, large *tidal* channels, and higher *salinity* waters. Some of these ponds should be restorable with a minimum of delay or engineering, as has happened with Pond 2A and Pond 3. Any needed desalination might be pursued by transferring brines to other ponds and admitting low-*salinity* winter flood flows. Ponds 9 and 10 also should be priorities for restoration, to expand habitat around the ecologically important remnant *marsh* at Fagan Slough.
- Petaluma baylands, on both sides of the river and toward the mouth, with opportunities for expanding habitat around rare species *populations* and restoring gradual gradients from high *marsh* well into *uplands*.

- Novato area baylands, including the former Hamilton Airfield and Bel Marin Keys, south to China Camp State Park, expanding and re-connecting habitat and *populations*.

Despite the extent of restoration planned in the region, gaps and barriers between *marsh* areas may remain, and it will be an additional priority to establish habitat connections between *marsh* areas to the greatest extent feasible. Habitat connectivity will increase the potential for *population* and *genetic* exchange, especially for less mobile species such as the salt marsh harvest mouse. If fringing marshes are used to establish connectivity, they should be as deep (from shore to bay) as possible from inboard to outboard edge, and should have wide and well vegetated high *tide* refugial habitat, capable of accommodating sea level rise.

Restoration around San Pablo Bay should seek to establish substantial areas of a wide diversity of *tidal marsh* and associated habitats. For example, sparsely vegetated *pans* in high *marsh* and gentle high *marsh* edges will increase habitat for *Cordylanthus mollis* ssp. *mollis*; high *tide* refugial habitat will benefit California clapper rail, salt marsh harvest mouse, California black rail, San Pablo song sparrow, Suisun shrew, and other species; shallow open ponds within *tidal marsh* will encourage a variety of water bird species; and *brackish marsh* areas and *riparian ecotones* will support California black rail and salt marsh common yellowthroat. *Seasonal wetlands* above most *tides* may provide habitat for *Lasthenia conjugens* and California red-legged frog. Opportunities to restore upland *ecotones* and accommodate upper extremes of sea level rise exist, for example, around the Petaluma Marsh, at American Canyon, Sears Point, Pinole Point, and other locations.

Flood protection needs will figure into feasibility and costs of *tidal* restoration projects around San Pablo Bay. In particular, portions of Highway 37, Lakeville Road, and certain railroad tracks may need diking, elevating, or other modification. Utilities in restoration areas should be removed or re-aligned. Another option for minimizing impacts to species and habitat is to remove access *levees* to existing poles and other structures and to use alternative means to access them. Raptor and corvid nests should be removed from electrical towers and gates resistant to mammalian predator access should be installed. Boardwalk development should be discouraged due to their tendency to provide access routes to mammalian predators.

Some land acquisition from willing sellers may be needed to allow regional *tidal marsh* restoration in San Pablo Bay to work more effectively for species recovery. Rational integration of flood control, infrastructure, *tidal* circulation and habitat connectivity are likely to be important considerations.

Management improvements and enhancement of existing *tidal marsh* habitats will aid recovery, for example to maintain *tidal* circulation, manage public access, and remove *non-native* species. Management plans for particular sites should be developed to sustain ecosystems and suites of rare species. For example, management at Point Pinole Regional Shoreline can conserve *Cordylanthus mollis* ssp. *mollis*, *Castilleja ambigua* ssp. *ambigua*, and *Suaeda californica*, as well as *tidal marsh* animals and *tidal marsh* ecosystems, *ecotones*, and buffers. Adequate long-term funding is needed for ongoing habitat management and monitoring.

Control and monitoring of *invasive* plants will be an ongoing management task in San Pablo Bay, as it is elsewhere in the *estuary*, with slightly different regional emphasis. Vigilant monitoring for *invasive Spartina* will be essential, to confine the smooth cordgrass hybrids' invasion to the southern *estuary* and to protect existing marshes, *Spartina foliosa populations*, and restoration projects. Eradication of *Spartina densiflora* should proceed at Point Pinole Regional Shoreline and Napa-Sonoma Marsh as well as south of San Pablo Bay in Marin County. *Lepidium latifolium* (perennial pepperweed) will present a major long-term challenge around San Pablo Bay, as this species is tenacious and has been increasing. This *perennial* may compete for space, light, and nutrients with native plants including *Cordylanthus mollis* ssp. *mollis*, *Cordylanthus maritimus* ssp. *palustris* (northern salt marsh bird's-beak), and *Castilleja ambigua* ssp. *ambigua* (salt marsh owl's-clover), potentially displacing them. There is concern that *Lepidium latifolium* also may displace *Grindelia stricta* (gumplant), an important species in providing high *tide* refuge for salt marsh harvest mouse and other animals. Yet another plant pest problem in the region is *Carpobrotus* [*Mesembryanthemum*] sp. (sea fig or ice plant), including extensive stands in the Napa-Sonoma marshes, and elsewhere (H. Shellhammer pers. comm. 2005). Restoration projects should include planning and dedicated, long-term funding for *invasive* species early detection, monitoring, and control from their outset. Control programs should specify success criteria and undergo periodic review.

Predators, notably *non-native* red fox, are a major problem for *marsh* birds—and probably species such as salt marsh harvest mice as well—around San Pablo Bay. Monitoring and control programs to address *non-native* or artificially abundant predators need to be implemented, maintained, and periodically reviewed. Though it has been determined that native Sierra Nevada red fox exist in the vicinity of Suisun Bay (B. Sacks *in litt*. 2009), further research is needed to determine whether that species is responsible for predation impacts to the rail there. Similar research will be necessary, particularly in the northern and western areas of San Pablo Bay if it is determined the native species of red fox resides there as well. Restoration projects should include planning and long-term funding for predator monitoring and control.

Sewage sludge (biosolids) disposal at Tubbs Island (at the mouth of Sonoma Creek) should be considered for relocation to an area with lower potential for clapper rail and salt marsh harvest mouse recovery, or to a non-bayland site. Hay cropping and sludge disposal could be transferred temporarily to another eventual *tidal* restoration site if Tubbs Island becomes available for restoration first.

Surveys. Biological inventory of remnant San Francisco Bay marshes has been incomplete: sporadic surveys over many years have been unevenly distributed, conducted with uneven thoroughness, and have failed to keep pace with rapid physical and biological changes. Periodic comprehensive species surveys covering plants, vertebrates, and invertebrates of conservation interest are needed throughout San Francisco Bay to identify critical declines in species abundance or distribution.

A research and planning need for the San Pablo Bay area is a regional spatial strategy for the management of *Lepidium latifolium*, mentioned above. Efficient spatial weed control strategies generally focus initially on outlying, pioneer colonies and seed sources, then gradually move inward toward core infestations, minimizing their area and extent of

contact with unaffected lands. The spatial distribution of *Lepidium latifolium* and its modes and pathways of spread need to be better understood in the region and applied in determining an efficient regional strategy for control. San Pablo Bay National Wildlife Refuge has recently made considerable progress in this regard on refuge lands, having censused *Lepidium latifolium* in marshes of the refuge, analyzed spatial patterns, prioritized control, developed a long-term control plan, and begun regional coordination (*e.g.*, with California Department of Fish and Game) (Hogle *et. al.* 2007). Another unanswered research need is how best to manage the large impounded areas throughout the marshes of San Pablo Bay which result in *Sarcocornia* die-offs and mosquito production. Finally, research is needed to examine the effect of coyotes on California clapper rail, red fox, and salt marsh harvest mouse.

Central/Southern San Francisco Bay

This discussion involves *tidal* marshes and former baylands from the Golden Gate Bridge north to a line between Pinole Point (Contra Costa County) and Point San Pedro (Marin County), and south to the furthest extent of San Francisco Bay), completely overlapping the Recovery Unit with the same name (**Figure III-4**). An example species planning checklist for the region is provided in **Table III-7**. Contact the U.S. Fish and Wildlife Service's Sacramento Fish and Wildlife Office for an updated list.

Table III-7. Regional Species Planning Checklist: Central/South San Francisco Bay

Federally listed species:

Animals

salt marsh harvest mouse, southern subspecies (*Reithrodontomys raviventris raviventris*)
southern sea otter (*Enhydra lutris nereis*)
California clapper rail (*Rallus longirostris obsoletus*)
western snowy plover (*Charadrius alexandrinus nivosus*)
California least tern (*Sterna antillarum browni*)
San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)
California red-legged frog (*Rana aurora draytonii*)
California tiger salamander (*Ambystoma californiense*)
tidewater goby (*Eucyclogobius newberryi*)
steelhead (*Onchorhynchus mykiss*)
chinook salmon (*Oncorhynchus tshawytscha*)
California vernal pool tadpole shrimp (*Lepidurus packardi*)

Plants

Suaeda californica (California sea-blite)
Lasthenia conjugens (Contra Costa goldfields)

Non-listed species covered by this draft recovery plan:

Animals

salt marsh wandering shrew (*Sorex vagrans halicoetes*)
San Pablo vole (*Microtus californicus sanpabloensis*)
California black rail (*Laterallus jamaicensis coturniculatus*)
saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*)
Alameda song sparrow (*Melospiza melodia pusillula*)
Samuels song sparrow (*Melospiza melodia samuelis*)
old man tiger beetle (*Cicindela senilis senilis*)

Plants

Spartina foliosa (California cordgrass)

Species of concern or regional conservation significance:

Animals

harbor seal (*Phoca vitulina*)
California sea-lion (*Zalophus californicus*)
Virginia rail (*Rallus limicola*)
sora (*Porzana carolina*)
Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*)
shorebirds, wading birds, waterfowl (multiple species)
peregrine falcon (*Falco peregrinus*)
western pond turtle (*Clemmys marmorata*)
green sturgeon (*Acipenser medirostris*)
longfin smelt (*Spirinchus thaleichthys*)
Pacific lamprey (*Lampetra tridentata*)
river lamprey (*Lampetra ayresi*)
Sacramento splittail (*Pogonichthys macrolepidotus*)
San Francisco forktail damselfly (*Ishnura gemina*)
old man tiger beetle (*Cicindela senilis senilis*)
western tanarthrus beetle (*Tanarthrus occidentalis*)
Jamieson's salt marsh wasp (*Compsocryptus jamiesoni*)

Plants

Agrostis exarata, Leymus triticoides, Puccinelia nutkaensis (salt marsh edge grasses)
Astragalus tener ssp. *tener* (alkali milk-vetch)
Aster lentus, A. chilensis and intergrades (salt marsh asters)
Aster subulatus var. *ligulatus* (slim aster)
Atriplex californica (California saltbush)
Atriplex joachiniana (San Joaquin saltbush)
Baccharis douglasii (salt marsh baccharis)
Cordylanthus maritimus ssp. *palustris* (northern salt marsh bird's-beak)
Castilleja ambigua ssp. *ambigua*, salt marsh populations (salt marsh owl's-clover)
native *Carex* spp. (salt marsh edge sedges)

Centaurium trichanthum (alkali centaury)
Cicuta maculata var. *bolanderi* (Bolander's spotted water-hemlock)
D*owningia pulchella* (valley Downingia)
Glaux maritima (sea-milkwort)
Heliotropium curassavicum (seaside heliotrope)
Hemizonia pungens ssp. *maritima, H. parryi* sspp. (spikeweeds, tarweeds)
Iva axillaris var. *robustior* (povertyweed)
Juncus spp. (perennial and *annual* rushes)
Lasthenia glabrata ssp. *glabrata* (smooth goldfields)
Lasthenia platycarpha (alkali goldfields)
Lepidium oxycarpum, *L. nitidum*, *L. latipes* (native annual peppercresses)
Plagiobothrys glaber (smooth popcornflower)
Plantago elongata (annual coast plantain)
Polygonum marinense (Marin knotweed)
Pyrrocoma racemosa (clustered goldenweed)
Pluchea odorata (marsh fleabane)
Puccinellia nutkanensis (alkali goosegrass)
Ruppia maritima (ruppia)
Sarcocornia subterminalis (Parish's glasswort)
Sanicula maritima (adobe sanicle)
Solidago confinis (southern goldenrod)
Suaeda moquinii (alkali-blite)
Senecio hydrophilus (salt marsh butterweed)
Zostera marina (eelgrass)

Because of intensive development, remaining habitat preservation and restoration opportunities for many species covered by this draft recovery plan are limited in the northern and central portions of the region. Most of the remnant and historic *tidal* marshes of the central Bay (Richardson Bay, Corte Madera, San Rafael, portions of the Oakland and Emeryville-Richmond shoreline) lack sizeable areas suitable for *tidal marsh* restoration, and can only be maintained or expanded to a limited degree. Many of these are "pocket" marshes or fringing marshes that support important local *populations* of rare or declining species (such as *Cordylanthus maritimus* ssp. *palustris* (northern salt marsh bird's-beak) and *Polygonum marinense* (Marin knotweed)), or provide hard-to-find suitable settings for species *reintroductions* (such as for *Suaeda californica* and *Atriplex californica* (California saltbush). Important pre-historic *marsh* remnants occur in central San Francisco Bay, such as Heerdt Marsh (Corte Madera) and Bothin Marsh (Mill Valley).

This draft recovery plan seeks to maximize connectivity for species that move through the Central Bay, providing resting or stepping-stone habitat in as large and healthy remnants as possible. It also seeks to reintroduce *populations* of *Suaeda californica* in appropriate or enhanced habitat. To that end, the isolated remnant marshes in this subregion should be protected against encroachment and degradation. Where feasible, they should be either expanded or modified to add missing associated habitats, such as terrestrial *ecotones*, shallow *lagoons*, *pans*, fresh-*brackish ecotones*, etc. Their associated inter*tidal mudflats* also should be

protected. Intensive control and monitoring of *non-native* and hybrid *Spartina* (cordgrass) is critical here, to prevent the infestation from spreading en mass to the North Bay and *tidal* marshes outside the *estuary*.

In south-central and south San Francisco Bay, confining and eliminating the *non-native* and hybrid *Spartina* invasion must be the first priority. Restoration opportunities abound here but will have to follow eradication of *invasive Spartina*. Not until it can be assured that new "restoration" areas will not become new *Spartina* control problems via nearby sources of *non-native Spartina* or hybrid *Spartina* pollen or seed should any restoration project move forward. It is important to remember that the impacts of an *invasive Spartina* plant are not limited to the immediate vicinity of the plant, but extend to the limit where its pollen blows and where all resulting hybrid seeds are carried by the *tides* and currents. Restoration projects should not be restored to *tidal* action without a realistic contingency plan for what will be done if, against expectation, *non-native Spartina* does invade the site. (One alternative may be to re-*dike* the site and inundate it long-term to kill *Spartina*.) Conservation of species like the California clapper rail with important *populations* in *non-native Spartina*-infested portions of South Bay *tidal* marshes will present challenges. Invasion by *Lepidium latifolium* in *brackish tidal* marshes of the Alviso area is also a problem, and will need control efforts to prevent it from worsening.

As discussed in section I.E., aggressive efforts to eradicate *invasive Spartina* by the Invasive Spartina Project have begun. The Invasive Spartina Project also monitors the distribution and progress of the hybrid *Spartina* invasion and control, and should be contacted for the latest information (California Coastal Conservancy offices, Berkeley, CA).

Predator control will be especially important in the south-central and south San Francisco Bay, around the significant *population* of California clapper rails. Field studies as well as *population* and viability modeling have shown that California clapper rail recovery is extremely sensitive to factors that affect survival rates or *population* growth rates, both of which are severely reduced by predation (Foin *et al.* 1997; also see **Appendix F**). Effective predator control will dramatically leverage the *tidal marsh* acreage restored for recovery of the rail.

Where *invasive Spartina* and *Lepidium latifolium* are effectively eradicated, *tidal marsh* restoration in San Francisco Bay can proceed, but will need to seek a balance between increased *tidal marsh* area and conservation of shorebirds and waterfowl that depend on what are now extensive salt ponds. Restoration of *tidal marsh* in south San Francisco Bay is the subject of large, multi-party efforts, such as the South Bay Salt Pond Restoration Project. These efforts have explored alternatives that reflect many of the considerations and tradeoffs discussed. The proposed project will develop according to adaptive management triggers.

Conservation management of the ponds that are part of the South Bay Salt Pond Restoration Project typically may follow a *tidal marsh* restoration track or a managed pond track. Careful monitoring of habitats and species, and adaptive management to guide the projects toward desired ends, will be needed. *Tidal marsh* restoration will have to incorporate measures to protect flood-prone developed lands and infrastructure, and maintain regionally adequate shallow water habitats for waterbirds.

In addition to *invasive Spartina*, a restoration constraint in the South Bay is fresh wastewater discharge from San Jose. The resulting increased *freshwater* influence has altered *tidal marsh* vegetation toward *brackish marsh* species, for example, in Artesian and Alviso Sloughs. *Brackish marsh* provides lower quality habitat for California clapper rails and salt *marsh* harvest mice. Excess nutrients or contaminants in the wastewater also may be having some effect; this has not been examined closely to date. Restoration within the influence of these fresh water discharges would be more likely to establish *brackish tidal marsh* than the typical salt *marsh* vegetation once found there. On the other hand, supplying the fresher water to *brackish marsh* restoration might diffuse the fresher flows and reduce impacts to fringing salt marshes along *tidal sloughs* in the area. The U.S. Fish and Wildlife Service will work with responsible agencies on all available means of reducing artificially high fresh water discharges to the South Bay.

Substantial *subsidence* in some South Bay ponds may make *tidal marsh* restoration that is reliant upon natural *sediment* deposition difficult or slow, and may require deposition of dredged materials or other fill material to increase pond bottom elevations prior to breaching. Some subsided ponds are within the influence of excess fresh wastewater discharges, and therefore, doubly problematic for *marsh* restoration. Ponds that are not among the highest priority candidates for *tidal marsh* restoration may be better allocated as waterbird habitat.

Without prejudging any particular restoration configuration, the following *restoration priorities* in the San Francisco Bay region have been identified. Please note that these priorities do *not* take into account the *invasive Spartina* constraints discussed above, because those conditions are subject to rapid change. These preliminary priorities therefore must be subject to evaluation of the latest local and regional conditions before being put into action:

- Newark area (Dumbarton-Mowry)
- Eden Landing (Alameda Flood Control Channel and Old Alameda Creek)
- Redwood City area (Bair, Greco Islands, Ravenswood area)
- remedying *invasive Spartina* problems at Eden Landing-Baumberg area and Cogswell Marsh restoration projects
- Hayward shoreline
- Warm Springs (control *tidal* flooding to limit drowning of *vernal pool* habitat)
- projects to create contiguous habitat and habitat linkages for listed species

Ultimately, if the remaining active salt ponds in Newark and Fremont on the east side of the Bay and west of the Ravenswood restoration area on the west side are someday no longer needed for salt production, they should also be considered for restoration to *tidal marsh* or water bird habitat. The Newark-Fremont section in particular otherwise creates a large separation in habitat between the Eden Landing project and the Dumbarton-Mowry, Warm Springs, and Alviso areas. The area northeast of Redwood City should be restored to create contiguous habitat between Bair Island and the Ravenswood Point salt ponds to be restored per the South Bay Salt Pond Restoration Project.

The San Francisco Bay region hosts many unique species with particular needs and opportunities. The southern subspecies of the salt marsh harvest mouse is restricted to this region, as is the Alameda song sparrow, and most core *populations* of the California clapper rail

are centered here. San Francisco Bay also has habitat essential to California least terns (U.S. Fish and Wildlife Service 1985*b*) and western snowy plovers (U.S. Fish and Wildlife Service 2007*b*), which have their own recovery needs. Opportunities exist in the Warm Springs (Fremont) area to integrate *tidal marsh* recovery planning with *vernal pool* ecosystem conservation, including the *tidal marsh* to *vernal pool* grassland *ecotone*. This *vernal pool* area is home to *Lasthenia conjugens*, *vernal pool* tadpole shrimp, and California tiger salamander, among other species. Opportunities for *Suaeda californica reintroduction* abound in San Francisco Bay, as well.

Surveys. Biological inventory of remnant San Francisco Bay marshes has been incomplete: sporadic surveys over many years have been unevenly distributed, conducted with uneven thoroughness, and have failed to keep pace with rapid physical and biological changes. Periodic comprehensive species surveys covering plants, vertebrates, and invertebrates of conservation interest are needed throughout San Francisco Bay to identify critical declines in species abundance or distribution.

Research. A regional research need in San Francisco Bay is a better understanding of *sediment* dynamics, how *sediment* suspension and deposition interact with *mudflats*, how *tidal*restoration will affect *sediment* availability, sedimentation rates, and *mudflat* areas. Another area needing work concerns mercury contamination in the South Bay, from abandoned mines and other sources. Studies are needed on the impacts of fresh wastewater input to the South Bay, and of proposed solutions to this problem.

Central Coast

This discussion involves coastal habitat from Bodega Bay (Sonoma County) south to Elkhorn Slough (Monterey County) (**Figure III-5**), though the Recovery Unit of the same name extends only from Bodega Bay to Pescadero Marsh (San Mateo County). The emphasis along the Pacific coast from Bodega Bay to the Elkhorn Slough area will be to conserve and enhance natural pockets of healthy *tidal marsh* in appropriate locations so as to maximize the connectivity of habitat for *tidal marsh* animals and plants. This draft recovery plan also seeks to enhance *tidal marsh* nurseries for ecologically or economically significant fish, such as salmonids and tidewater goby. The goals of this draft recovery plan have been designed to complement the goals described for these species which are detailed in their own recovery plans. The decline of coastal California black rail *populations* should be addressed and to the maximum extent possible, reversed. A checklist of species to consider in planning for the region is given in **Table III-8**. Please contact the U.S. Fish and Wildlife Service's Sacramento Fish and Wildlife Office for an updated list.

Table III-8. Regional Species Planning Checklist: Central Coast

Federally listed species:

Animals

California clapper rail (*Rallus longirostris obsoletus*)
western snowy plover (*Charadrius alexandrinus nivosus*)

southern sea otter (*Enhydris lutris nereis*)
California red-legged frog (*Rana aurora draytonii*)
tidewater goby (*Eucyclogobius newberryi*)
steelhead (*Onchorhynchus mykiss*)
Chinook salmon (*Oncorhynchus tshawytscha*)

Plants

Lupinus tidestromi (Tidestrom's lupine)

Non-listed species covered by this draft recovery plan:

Animals

salt marsh wandering shrew (*Sorex vagrans halicoetes*)
California black rail (*Laterallus jamaicensis coturniculatus*)
saltmarsh common yellowthroat (*Geothlypis trichas sinuosa*)

Plants

Spartina foliosa (California cordgrass)

Other species of regional conservation significance:

Animals

harbor seal (*Phoca vitulina*)
California sea-lion (*Zalophus californicus*)
Virginia rail (*Rallus limicola*)
sora (*Porzana carolina*)
Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*)
shorebirds, wading birds, waterfowl (multiple species)
peregrine falcon (*Falco peregrinus*)
tiger beetle species (*Cicindela* spp.)

Plants

Astragalus pycnostachyus ssp. *pycnostachyus* (marsh locoweed)
Atriplex californica (California saltbush)
Cordylanthus maritimus ssp. *palustris* (northern salt marsh bird's-beak)
Castilleja ambigua ssp. *ambigua* (salt marsh owl's-clover)
Castilleja ambigua ssp. *humboldtiensis* (Humboldt Bay owl's-clover, southern form)
Castilleja ambigua ssp. *ambigua* (salt marsh owl's-clover)
Lasthenia glabrata ssp. *glabrata* (smooth goldfields)
Polygonum marinense (Marin knotweed)
Hemizonia parryi ssp. *congdonii* (Congdon's tarplant)
Agrostis exarata, Leymus triticoides, Puccinelia nutkaensis (salt marsh edge grasses)
Aster subulatus var. *ligulatus* (slim aster)
Atriplex californica (California saltbush)
Baccharis douglasii (salt marsh baccharis)
Carex spp. (salt marsh edge sedges)

Cicuta maculata var. *bolanderi* (Bolander's spotted water-hemlock)
Glaux maritima (sea-milkwort)
Heliotropium curassavicum (seaside heliotrope)
Hemizonia pungens ssp. *maritima* (maritime spikeweed*)*
Juncus spp. (perennial and *annual* rushes)
Lepidium oxycarpum, *L. latipes* (native annual mustards)
Leymus triticoides (creeping wildrye —salt marsh edge populations)
Plantago elongata (annual coast plantain)
Pluchea odorata (marsh fleabane)
Rumex occidentalis (western dock)
Ruppia maritima (ruppia)
Zostera marina (eelgrass)

Marin-Sonoma coast. Species recovery and conservation strategies for the coast of Marin and Sonoma counties emphasize range re-expansion of the California clapper rail and California black rail, and conservation of five rare plants with important localities in Tomales Bay and Drakes Bay: *Astragalus pycnostachyus* ssp. *pycnostachyus*, *Castilleja ambigua* ssp. *humboldtiensis*, *Castilleja ambigua* ssp. *ambigua*, *Cordylanthus maritimus* ssp. *palustris*, and *Polygonum marinense*. In addition, there are a number of plants which have declined in California's *tidal* marshes, particularly the San Francisco Bay Estuary, but which persist in coastal Marin County, such as *Lasthenia glabrata* ssp. *glabrata*, *Atriplex californica*, and *Rumex occidentalis*. The west Marin *tidal* marshes should be managed as an important refuge for *tidal marsh* plant *populations* otherwise in regional decline. Coastal *Spartina foliosa populations* should be protected, monitored, and any *invasive non-native Spartina* eradicated immediately.

At the mouths of many small seasonal streams discharging into *embayments* of the coast are small *brackish* to fresh *lagoons* associated with small *barrier beaches*. These features include *ecotones* between *riparian* ecosystems, *freshwater* ponds and *tidal marsh*. These support sizeable *populations* of California red-legged frogs, and provide opportunities to integrate the recovery objectives for this species (U.S. Fish and Wildlife Service 2002*a*) with recovery of *tidal marsh* ecosystems.

San Mateo-Santa Cruz coast. The most significant estuaries of the coast of San Mateo and northern Santa Cruz counties for conservation of rare or listed species are at Pescadero Creek, Pomponio Creek, San Gregorio Creek, and Pillar Point marsh. Lake Lucerne at Bean Hollow (Arroyo de los Frijoles), a dammed *estuary* converted to a *freshwater* pond, has potential for *tidal marsh* restoration. Pilarcitos Creek, Tunitas Creek, Waddell Creek, and Scott Creek support high quality fresh-*brackish marsh* and *riparian ecotones*. All but Lake Lucerne and Tunitas Creek are publicly owned. In accordance with their respective recovery plans, sub-tidal, *tidal* and intermittently *tidal* (*lagoon*) aquatic habitat areas should be preserved in stream mouths to support tidewater goby and salmonid *populations* (U.S. Fish and Wildlife Service 2005).

Publicly owned stream mouth and *lagoon* wetlands should be managed with priority to protect or restore native ecosystems. Long-term habitat management plans should be prepared and implemented. *Brackish tidal*and *riparian marsh ecotones* in San Mateo coast estuaries should be protected and enhanced, where appropriate, for saltmarsh common yellowthroats and California

black rails. Another important recovery strategy for these estuaries is to foster "stepping stone" habitats for vagrant California clapper rails, to support infrequent but biologically important future emigration from San Francisco Bay to Elkhorn Slough (Monterey Bay). These estuaries similarly provide habitats for dispersing yellowthroats and black rails. Managing and restoring upper fresh-to-*brackish* reaches of *tidal marsh* gradients also should provide habitat (backshore *lagoons* and ponds, *riparian* areas with scour pools) for California red-legged frogs.

The Pescadero Marsh Estuary is exceptional in supporting a major *population* of the California red-legged frog, principally in the managed, *diked brackish*-fresh *marsh* derived from and adjacent to the *tidal estuary*. Because of the high importance of this *population* to the recovery of the California red-legged frog (U.S. Fish and Wildlife Service 2002*a*), and the occurrence of a significant *Astragalus pycnostachyus* ssp. *pycnostachyus* (*marsh* locoweed) *population* on the low *dike* and in portions of the *diked marsh*, full *tidal*restoration (*dike* demolition) is not currently justified for Pescadero Marsh. Long-term planning for Pescadero Marsh, however, should re-investigate the feasibility of reducing artificial management (*dikes* and water control structures) over time, and integrating fresh-*brackish lagoons* or ponds and *marsh* habitats within a matrix of mixed *tidal*and *riparian marsh* habitats. Examples of such systems may be found in the stream mouth estuaries in Tomales Bay, Drakes Estero, Halfmoon Bay, and Morro Bay.

Because estuaries can be affected by their upstream watersheds, estuarine enhancement actions in the San Mateo coast region should include floodplain and *riparian* vegetation restoration in derelict agricultural lands, such as at Pomponio Creek. When bridges or culverts over stream mouths are proposed for retrofitting or upgrading, they should be redesigned to minimize restrictions of flows and to allow unobstructed passage of fish, frogs, and other animals.

Invasive non-native plants, such as iceplant (*Carpobrotus* sp.) and European beachgrass (*Ammophila arenia*), should be eradicated from *tidal marsh* areas to the greatest extent feasible, concentrating on highest risk species and most effective control strategies first. Monitoring and management actions to control *non-native* species, including *non-native invasive* animals, should be instituted.

Privately owned stream mouths with *brackish marsh* or intermittent *lagoon* habitat, such as Tunitas Creek, should be protected by either easement or fee-title acquisition from willing sellers. If Lake Lucerne becomes available for land uses which do not require the impoundment, it would be a priority for protection and *lagoon*/*marsh*/*riparian* restoration. As the second largest stream-mouth *estuary* of this region, following Pescadero Marsh, a restored *marsh* at the present location of Lake Lucerne likely could support *tidal marsh* species of concern, as well as tidewater goby, red-legged frogs, and dispersing California clapper rails, in various restored habitats.

In appropriate publicly owned habitats, regular surveys for and monitoring of rare native plant and animal species should be conducted. Management plans and management activities should be adapted to address any *populations* discovered or significant changes in *population* size or distribution.

Elkhorn Slough and Monterey estuaries and lagoons. Elkhorn Slough is ecologically important as an *estuary*, but has proportionally less habitat potential for endangered *tidal marsh* species than the San Francisco Bay Estuary and Morro Bay. Its current principal recovery strategies are to maintain habitat for western snowy plovers in the salt *pan* (former salt pond) habitats near its mouth, as well as southern sea otter habitat in the *slough* itself. The *tidal* marshes of Elkhorn Slough may have been important refuges for vagrant clapper rails from San Francisco Bay, and may have acted as *founders* of new *populations* in Monterey Bay or Morro Bay; however California clapper rails have not been detected in Elkhorn Slough for decades. Other species conservation strategies for Elkhorn Slough include maintaining *riparian brackish marsh* habitat for black rails and yellowthroats; high habitat quality and abundance for migratory shorebirds and waterfowl; supporting a persistent or recurrent *population* of tidewater gobies; and conserving plant species of concern.

Elkhorn Slough's endangered species recovery potential, unlike that of San Francisco Bay, has not been greatly impaired by diking and agricultural reclamation, so *tidal marsh* restoration will not be a principal recovery strategy here. Instead, the main long-term threats to *tidalmarsh* that are potentially manageable at Elkhorn Slough are (1) invasion by *non-native* red fox, an important predator of clapper rails; (2) reduction and suppression of native high *marsh* vegetation and terrestrial *ecotones* that provide cover during high *tides*, a result of intensive rangeland management practices; and (3) excessive *tidal prism*, *tidal* energy and *marsh* erosion caused by the Moss Landing jetties which stabilize the *tidal* inlet and prevent natural *tidal* damping by sandspit growth.

Predator control is a high priority for ensuring breeding success of western snowy plovers already established at the Moss Landing *salt pans*, managed by California Department of Fish and Game. Mammalian predator control to protect plovers in Monterey Bay began at the Salinas River National Wildlife Refuge in 1993 (U.S. Fish and Wildlife Service *in litt.* 1993), focusing on removal of red fox and artificially abundant native species. Since that time, the program has expanded to include plover habitat on adjacent public and private properties, including Moss Landing *salt pans* and state beaches. In 2002, predator management was expanded to include avian predators (U.S. Fish and Wildlife Service 2002*b*). This management program protects both plovers and recolonization potential for clapper rails.

Conservation easements or land acquisition should be used to secure opportunities to manage, enhance, or restore high *tidal marsh ecotones* and floodplain and *riparian* areas around Elkhorn Slough, including *brackish marsh* areas and seeps. Important elements of restoration of high *marsh ecotones* would include revegetation with semi-evergreen sub-shrub vegetation such as gumplant (*Grindelia* sp.) and *Baccharis douglasii* (salt marsh baccharis) to provide high *tide* cover for clapper rails. Some *tidal marsh* edges at Elkhorn Slough may be suitable for restoration of *tidal marsh*/alluvial grassland *ecotones*, and potential establishment of *Hemizonia parryi* ssp. *congdonii* (Congdon's tarplant) within its *historic range*.

Studies of progressive erosion of *marsh* edges caused by excess *tidal* energy in Elkhorn Slough should be updated (evaluating rates of *marsh* shoreline retreat, and loss of creek bank edges important to clapper rails). If justified by updated *marsh* erosion studies, environmental engineering alternatives to mitigate excess *tidal* energy east of Highway 1 should be planned, reviewed, and implemented. Since modification of jetties or navigational capacity of Moss

Landing is impracticable, alternatives evaluated to reduce excess *tidal* energy in the *estuary* should include a sub*tidal* sill (a submerged structure locally raising channel bed elevation, resisting bed erosion) to subdue *tidal*range without causing obstructions to aquatic life, particularly southern sea otters.

Several heavily-impacted *tidal*or muted *tidal sloughs* occur in the area around the Pajaro River, Elkhorn Slough, and the Salinas River. Their potential for rehabilitation and restoration may deserve consideration in local planning efforts.

Morro Bay and South Central Coast

This discussion involves the coast from Elkhorn Slough to Morro Bay and focuses on protection and enhancement of existing habitats and *populations* of sensitive *tidal marsh* species (**Figure III-6**). The Recovery Unit of the same name covers only Morro Bay not areas to the north. A list of some species of regional planning significance is given in **Table III-9**. Please contact the U.S. Fish and Wildlife Service's Ventura Fish and Wildlife Office for an updated list.

There was probably some loss of *tidal marsh* in Morro Bay historically, but total *tidal marsh* acreage has actually increased substantially over its historic extent in Morro Bay. This increase has occurred mostly at lower *marsh* elevations, however, and not in the high *tidal marsh* zones and *tidal marsh*/upland edge likely to provide habitat for endangered *Suaeda californica* (California sea-blite) and *Cordylanthus maritimus* ssp. *maritimus* (salt marsh bird's-beak). The majority of Morro Bay Estuary edge is either in public or conservation group ownership (*i.e.,* state and city parks, Morro Coast Audubon) or has already been developed; the remaining area of private, undeveloped habitat is small.

Table III-9. Regional Species Planning Checklist: Morro Bay

Federally listed species:

Animals

clapper rail (*Rallus longirostris*) (subspecies requires investigation)
western snowy plover (*Charadrius alexandrinus nivosus*)
California red-legged frog (*Rana aurora draytonii*)
Tidewater goby (*Eucyclogobius newberryi*)
Morro shoulderband snail (*Helminthoglypta walkeriana*)

Plants

Suaeda californica (California sea-blite)
Cordylanthus maritimus ssp. *maritimus* (salt marsh bird's-beak)

Other species of regional conservation significance:

Animals

harbor seal (*Phoca vitulina*)
California sea-lion (*Zalophus californicus*)

California black rail (*Laterallus jamaicensis coturniculus*)
Bryant's savannah sparrow (*Passerculus sandwichensis alaudinus*)
large-billed savannah sparrow (*Passerculus sandwichensis rostratus*)
shorebirds, wading birds, waterfowl (multiple species)
peregrine falcon (*Falco peregrinus*)
steelhead (*Onchorhynchus mykiss*)

Plants

Atriplex californica (California saltbush)
Atriplex watsonii (Watson's saltbush)
Juncus acutus ssp. *leopoldii* (Leopold's spiny rush)
Lasthenia glabrata ssp. *coulteri* (Coulter's goldfields)
Sanicula maritima (marsh sanicle)
Solidago confinis (southern goldenrod)
Zostera marina (eelgrass)

The recovery strategies for Morro Bay *tidal marsh* species aim at supporting an extensive persistent wild *population* of *Suaeda californica* in its last naturally remaining locale, and maintaining the distinct northern *population* of *Cordylanthus maritimus* ssp. *maritimus*. This strategy includes maintaining physical and ecological processes that maintain or regenerate habitat for these listed plants. Secondary strategies for this region include: (a) providing future habitat (and potential reoccupation of *historic range*) for the California clapper rail (or forms intermediate with the light-footed clapper rail); (b) protecting *brackish marsh* habitat, willow *riparian*/*brackish marsh ecotone*, and *populations* of California black rails and; (c) protecting or expanding local *populations* of *Lasthenia glabrata* ssp. *coulteri*, *Atriplex watsonii*, *Atriplex californica* (salt *marsh ecotypes*), and the salt *marsh population* of *Solidago confinis*. The salt *marsh population* of *Juncus acutus* ssp. *leopoldii* is at its northern coastal range limit at Morro Bay, and should be protected. It is important to seek compatibility of actions under this draft recovery plan with high quality habit for shorebirds including western snowy plover, wading birds, waterfowl, eelgrass, tidewater goby and Morro shoulderband snail.

Remaining undeveloped shoreline around Morro Bay (*tidal marsh* to extreme high water, adjacent upland transition, and a buffer zone) should be protected from further encroachment by development or artificial shoreline, and from land use conflicts. Where possible, undeveloped private shoreline should be permanently protected by acquisition or conservation easement from willing sellers. Policies and oversight related to all land use practices in and adjacent to *tidal marsh* around Morro Bay should be reviewed and updated by the City of Morro Bay and other regulatory authorities to ensure that impacts to remaining shoreline and *marsh* are avoided. Rules on haul-out of skiffs, canoes, and other watercraft on public properties, including State-owned *tidal* lands, should be evaluated, refined, and consistently applied to minimize impacts to existing and potential *tidal marsh* habitat of endangered plants. Recreational use of the shoreline should be managed to prevent impacts such as excessive trampling or off-road vehicle use. Monitoring and success criteria for these strategies should be established.

Management of conservation lands appropriate to the species covered by this draft recovery plan should be continued and enhanced. Management funding needs should be secured. Comprehensive adaptive management plans for each land unit, addressing these species, should be developed, reviewed, and implemented. Species and habitat monitoring and success criteria should explicitly be included and periodically reviewed. *Population augmentation*, or establishment of new sub*populations* of rare plant species (particularly *Cordylanthus maritimus* ssp. *maritimus, Suaeda californica* , and *Lasthenia glabrata* ssp. *coulteri* (Coulter's goldfields)) in suitable habitat around Morro Bay, should be planned and implemented (or continued) to reduce the risk of extinction.

Carpobrotus edulis (iceplant) and other *invasive non-native* plants should be eradicated, with highest priority in areas where they impact the survival or regeneration of rare native species. *Non-native* trees and shrubs such as *Eucalyptus* spp., *Myoporum laetum*, and *Cupressus macrocarpa* should be removed when they are adjacent to rare plant habitats or potential habitat—except at sites used as rookeries by herons, egrets, and cormorants. Invasion of weedy *non-native Cardaria draba* (whitetop) in deltaic *brackish tidal* marshes of the Chorro Creek mouth should be reduced to conserve habitat of California black rail.

Any future dredge disposal should be planned to avoid excessive dune migration onto *tidal marsh* habitat, and to maximize nesting habitat of western snowy plover. Sub*tidal* colonies of *Zostera* spp. (eelgrass), which form *wrack* lines that influence seedling habitat in the upper *marsh*, should be monitored and protected from dredging.

Groundwater extraction in the Los Osos Valley area, and channelization or diversion of surface drainage, should be managed to prevent the intrusion of high-*salinity* water into what are now *brackish* alluvial edges of *tidal marsh*. This is needed to maintain the *brackish* edge flora of the *tidal marsh*, and to conserve potential habitat for *Sanicula maritima* (marsh sanicle). The current planning efforts for a new wastewater treatment facility in Los Osos (San Luis Obispo County 2008*b*) should consider ways to ameliorate the threat of salt water intrusion in the area.

3. Species-level recovery strategies

While many of the threats to *tidal marsh* species are common to all (see section I.B.4) and should be addressed at the ecosystem level (see section III.B.1), there are also specific threats to individual species that must be reduced or eliminated to recover those species. This section will address species-specific recovery/conservation strategies to reduce or ameliorate threats to the six listed species and the species of concern covered in this draft recovery plan.

a. Focal listed species

1. *Cirsium hydrophilum* var. *hydrophilum* (Suisun thistle)

Since habitat loss is the primary reason for the decline of *Cirsium hydrophilum* var. *hydrophilum*, restoration of extensive areas of *tidal brackish marsh* habitat in areas contiguous with currently occupied habitat is necessary for recovery of the species. However, it may take decades to

achieve this long-term goal of favorable *tidal marsh* soil and *hydrologic* conditions. In the meantime, it will be essential to protect existing *populations* from further decline and possible extinction.

Short-term recovery actions should be implemented concurrently with long-term habitat restoration and should focus on protecting and managing existing *populations* and habitats. Recovery strategies include:

- suppression of *invasive non-native* plant species,
- protection and management of nearby native bee and wasp habitats,
- control of *Cirsium vulgare*, if research indicates necessity
- restoration of normal *tidal* range and *salinity*,
- *seed banking* of *Cirsium hydrophilum var. hydrophilum,*
- monitoring of *populations* and habitat, and
- research aspects of life history, population ecology, and seed predation of *Cirsium hydrophilum var. hydrophilum.*

The major *populations* of *Cirsium hydrophilum* var. *hydrophilum* occur at Hill Slough and Rush Ranch on lands owned by California Department of Fish and Game and Solano Land Trust. Although managed for conservation purposes, threats remain from grazing and trampling by cattle or feral pigs, as well as from invasion by *Lepidium latifolium* (perennial pepperweed). A comprehensive management plan for these lands is lacking and basic research on the biology of the species is needed before such a plan can be developed. Management actions to protect against known threats should be implemented immediately. Concurrently, essential research should be undertaken to begin the preparation of a comprehensive management plan. For existing or newly dedicated conservation lands, management plans guiding actions for *Cirsium hydrophilum* var. *hydrophilum* should be in place within 5 years; or if research and understanding is not adequate for a comprehensive plan, interim management plans should be completed and implemented. Adequate funding should be ensured to implement actions, operations, and maintenance required by interim or comprehensive management plans.

Successful long-term recovery will require large-scale habitat restoration and establishment of new *populations*. Extensive and variable habitat would ensure *refugia* during *catastrophic* events (*e.g.,* floods, droughts, pest and disease outbreaks) and progressive environment change (*e.g.,* sea level rise, climate change) and would spread the risks of extinction over many relatively independent *populations*. Extensive and contiguous bands of restored *tidal brackish marsh*, focused on areas north, west and south of Potrero Hills will be the foundation for long-term recovery. Restoration in a large portion of this area has already been initiated by California Department of Fish and Game. Restoration projects should include plans for establishing *Cirsium hydrophilum* var. *hydrophilum populations* as well as comprehensive plans addressing project management both during and after restoration work. Adequate funding for long-term conservation management of the project lands should be ensured.

To protect against extinction, collection and banking of seed from wild *populations* of *Cirsium hydrophilum* var. *hydrophilum* must occur. This would ensure that 1) *populations* could be re-established if known *populations* fail, and 2) *genetic* diversity could be maintained following a *catastrophic population* crash. Seeds should generally be collected in years of peak abundance,

but a small collection should be established immediately, even during adverse *population* conditions. Collection protocols should follow basic scientific guidelines (Center for Plant Conservation 1991), but manipulation of randomly selected seed parents would be appropriate in low *population* years to ensure adequate production of seed for collection. This could include protection against seed or ovule predation by introduced thistle weevils (*Rhinocyllus conicus, Larinus planus*) and muslin bagging of maturing flower heads. Seed collection should not exceed 1 percent of the estimated total *population* seed output. Collected seed should be stored at two facilities: (1) a seed storage facility approved by the Center for Plant Conservation, and 2) a local research or vegetation management/restoration institution (*e.g.,* university, public refuge, or park) with greenhouse and nursery facilities that could propagate seed.

A cultivated *population* of *Cirsium hydrophilum* var. *hydrophilum* should be established for research purposes. This cultivated *population* can provide seed to be used for research in basic biology, management, and propagation of the species, and thus avoid conflicts with conservation goals for the wild *populations*. The cultivated *population* should be established with *founders* sampled according to the same guidelines as *seed banks* and should be managed to minimize artificial selection and *genetic* drift in cultivation (Guerrant 1996). Suisun thistles should be seeded into *tidal marsh* restoration areas within the *historic range* of the species as soon as habitat is available, and if collection from the wild would risk impacts to the remaining *population*s there, seed from a cultivated *population* should be made available. Use of easily available cultivated seed also would make it possible to test the possible appropriateness of various habitat conditions more freely than with limited wild seed. Areas opened up by successful control of *Lepidium latifolium* or of other *non-native* plants may be appropriate for trials of cultivated thistle seed.

If hybridization with bull thistle (*Cirsium vulgare*) is detected, bull thistles within pollination distance of *Cirsium hydrophilum* var. *hydrophilum* should be prevented from flowering. Similarly, if bull thistle is suspected of fostering introduced thistle weevil *populations* that are harming Suisun thistles, bull thistles near Suisun thistles should be controlled.

A long-term *population* monitoring plan for *Cirsium hydrophilum* var. *hydrophilum* must be developed. The most basic data for conservation of the species, census of juvenile and adult plants in the wild, need to be collected annually. *Population* monitoring should include grid-based census and mapping of known *populations*, with surveys expanded in subsequent years to detect *peripheral* colonies or new *populations*. Preliminary data from initial monitoring studies should be gathered prior to development of the long-term monitoring plan. Long-term monitoring should include sufficient *demographic* sampling to identify factors and life-history stages that limit regeneration or expansion of *populations* (*e.g.,* non-destructive sampling of seed set, production of flower heads per plant, production of mature seed in seed heads, seedling density, juvenile survivorship, duration of juvenile phase, etc.).

Due to the extremely limited number of known *populations*, searches should include attempts to detect and resurrect soil *seed banks* of *Cirsium hydrophilum* var. *hydrophilum*, especially in pre-historic *tidal* marshes within Suisun Marsh. Probe methods should include germination tests of shallow *marsh* soil cores, and experimentally induced small-scale vegetation gaps in unoccupied suitable habitat. Any seedlings recruited from exhumed *seed banks* should be grown and

protected on-site if possible, or cultivated if artificial propagation is more likely to result in survival. Resurrected *populations* should be utilized as *founders* of reintroduced *populations* in unoccupied or restored habitat.

The highest priority research questions address regeneration of *Cirsium hydrophilum* var. *hydrophilum* in the wild, particularly those factors subject to strong fluctuation or artificial manipulation. Research is also needed on the *population* ecology of the species in relation to *marsh* soil *salinity* and *tidal* regimes to inform decisions regarding *salinity* control gates and water quality standards. For ecologically meaningful results, this research must span more than a precipitation cycle (drought/post-drought) and include both monitoring of natural field conditions and controlled field experiments. This would take approximately 5 to 10 years. Other essential research could be completed more quickly including 1) investigation of seed germination and establishment in natural and artificial conditions, 2) evaluation of seed predation by thistle weevils, 3) methods of control of *Lepidium latifolium* compatible with Suisun thistle and its habitat, 4) techniques for artificial propagation, and 5) potential for hybridization with *non-native* thistles (especially *Cirsium vulgare*).

2. *Cordylanthus mollis* ssp. *mollis* (soft bird's beak)

Recovery strategies for *Cordylanthus mollis* ssp. *mollis* include both long- and short-term elements. Immediate steps are needed to protect and maintain remaining *populations* and habitat of the species. In the long-term, significant re-expansion of the range and *population* of the species, with an increase in the extent and quality of its habitat, will foster recovery. Large-scale habitat restoration is needed to allow natural fluctuations in *population* size and distribution to occur with a minimal risk of extinction. However, it will probably take several decades to develop adequate *tidal marsh* habitat through natural processes. In the interim, short-term recovery actions are necessary to ensure survival of the species while habitat restoration is underway.

Short-term recovery actions should be implemented concurrently with long-term habitat restoration and should focus on protecting and managing existing *populations* and habitats. Recovery strategies include:

- suppression of *invasive non-native* plant species,
- protection and management of nearby native bee and wasp habitats,
- management of grazing and control of feral hogs to reduce trampling and disturbance,
- management of vehicle access and recreation,
- management of urban runoff,
- restoration of normal *tidal* range and *salinity*,
- *seed banking* of *Cordylanthus mollis* ssp. *mollis,*
- monitoring of *populations* and habitat, and
- research aspects of life history of *Cordylanthus mollis* ssp. *mollis.*

Non-native plant control should target *Lepidium latifolium* at Hill Slough, Rush Ranch, Benicia State Recreation Area, and other *population* locations. Control of this and other *non-native perennial*s should be conducted to ameliorate threats involving competition and tendency toward monoculture. *Spartina patens* at BSRA should be eradicated if possible. Research also suggests

that control of *non-native* winter *annuals* that invade upper *tidal marsh* habitats, such as *Polypogon monspeliensis* (annual beard grass), *Hainardia cylindrical* (barbgrass), and *Cotula coronopifolia* (brass-buttons), may increase survival of *Cordylanthus mollis* ssp. *mollis* seedlings (Grewell *et al*. 2003). Control of *non-native* winter *annuals* should also be conducted for reasons discussed above, involving their inability to serve as appropriate host plants.

Protection of native pollinators and their habitats should maintain or enhance *viable* seed production. Ground-nesting species of bumblebees are probably among the more effective pollinators (*Bombus occidentalis*, *Bombus vosnesenskii*). Adaptive management for and monitoring of ground-nesting and other native bees, particularly near *Cordylanthus mollis* ssp. *mollis populations*, is needed. Protection of predatory wasps that feed on moth larvae infesting *Cordylanthus mollis* ssp. *mollis inflorescences* should reduce losses of reproductive output to seed-eaters. The nesting and feeding habits of these species will be important in determining appropriate management. The U.S. Fish and Wildlife Service recommends restoration of healthy ecosystem characteristics to support beneficial native species, as opposed to artificial enhancements.

Management of grazing should aim to reduce trampling and breaking of *haustorial* connections to host plants due to disturbance. In addition to direct mortality, soil and plant disturbance by domestic livestock can create conditions that encourage invasion by *non-native* plants. These sorts of effects should be minimized. Disturbance by feral hogs (*Sus scrofa*) is similar in effects, but includes digging (rooting), and is controlled differently. Limited feral hog hunting has been allowed in portions of Suisun Marsh, but a regional-scale eradication effort should be coordinated with CDFG to decrease the species' impact on sensitive plants and their habitats.

Controls should be erected and maintained to prevent illict off-road vehicle use in habitat of *Cordylanthus mollis* ssp. *mollis*. Necessary legitimate vehicular use near appropriate habitat, such as by *levee* crews, mosquito abatement or wildlife personnel, researchers and the like, is appropriate but potential impacts to the species should be considered and avoided. Similarly, planning for maintenance of *levees*, ditches, and other features or structures should consider and avoid impacts to *Cordylanthus mollis* ssp. *mollis* and its habitat. Recreational and research access may need to be redirected or redesigned if impacts to the species or habitat appear likely.

Where urban runoff has displaced former *tidal marsh* habitat at Benicia State Recreation Area with *freshwater* emergent *marsh*, solutions should be identified to direct the runoff away from sensitive habitat.

Natural *tidal* cycles should be maintained or restored, since their resulting effects on vegetation and soil chemistry are important to the persistence of *Cordylanthus mollis* ssp. *mollis*. Upper *marsh* areas with periodic *tidal* flooding and moderate to high soil *salinity* (due to evaporative concentration of *tidal* salts), the resulting low-stature vegetation, and low abundance of *non-native*s or winter *annuals*, are vital to the species. In particular, recent modifications to *tidal* fluxes at the important Hill Slough *population* need to be examined and any necessary fixes implemented promptly. As discussed in section II.B.2.B.1., *salinity* and flow manipulations via the Montezuma *salinity* control gates should be evaluated in light of possible consequences for *populations* of *Cordylanthus mollis* ssp. *mollis*.

Seed banking is recommended for *Cordylanthus mollis* ssp. *mollis*, including banking from different *population* areas. *Seed banking* should represent the range of diversity of the species, at least geographically, and also genetically if this information becomes available. Seed collection should follow standard precautions to minimize impacts to rare plant *populations* (Center for Plant Conservation 1991).

In addition to monitoring needed for appropriate management and tracking of progress toward recovery, it is recommended that field surveys be conducted for additional, as-yet undiscovered *populations* of *Cordylanthus mollis* ssp. *mollis*. Any *populations* found will assist in expanding the remaining distribution of the species, reducing extinction risk across all *populations*, and possibly increasing the scope of *genetic* diversity of the species. To minimize damage to individual plants, presence-absence surveys should be used, if possible, for reconnaissance purposes and in determining within *marsh* distribution of extant *populations*. Hydrogeomorphic landscape position of the *population* patch (*i.e*., high *marsh*, upland transition, first order *tidal*creek edge/natural *levee*, drainage divide, high *marsh* plain) should be noted. In areas where more detailed abundance information is required, a logarithmic abundance class approach to estimating *population* size should be used in place of attempting to count individuals (*i.e.*, 1-10, 11-100, 101-1000, etc,). The process of parting the plant patches for accurate counts also results in high mortality as counters often unintentionally dislodge fragile *hemiparasite* root connections to host plant roots (Grewell pers. comm. 2009).

Given the importance of a host plant community comprised of a matrix of native *perennials*, information on host plants within *Cordylanthus mollis* ssp. *mollis population* patches should also be gathered. In late spring/early summer, sampling plots should be established and information gathered on percent cover of each species within the plot. This information should be compared to logarithmic abundance classes of *Cordylanthus mollis* ssp. *mollis*. Survey databases maintained by the California Department of Fish and Game and the non-profit California Native Plant Society may aid in conservation planning and protection.

Research is needed on many aspects of life history and conservation of *Cordylanthus mollis* ssp. *mollis*. Methods and effects of *non-native* plant control are among the highest priority topics. Other important subjects include, but are not limited to: effectiveness of various pollinators and any natural self-pollination; techniques to restore appropriate habitat; *reintroduction* methods; pre-dispersal seed granivory and other factors affecting seed dispersal, seed survival and seed germination; parasite-host relationships and relative benefit of various host species; and the benefits and impacts of different management practices.

In regards to pre-dispersal seed predation, research should be conducted into current herbivory rates by moth larvae (*Saphenista* spp., Tortricidae and salt marsh snout moth, *Lipographis fenestrella*, Pyralidae) in *Cordylanthus mollis* ssp. *mollis* rangewide. To minimize damage to individual *Cordylanthus mollis* ssp. *mollis* plants, only a subsample of capsules from plants of selected plots should be inspected for evidence of herbivory (*frass*, boreholes, damaged seed or lack of mature seed) (Grewell *in litt*. 2009). Also, preserving and managing nearby native habitat for predators, parasites, and diseases of the seed-damaging species would likely benefit *Cordylanthus mollis* ssp. *mollis population* dynamics.

Over the longer term, restoration of suitable *tidal marsh* habitat and introduction/ *reintroduction* of *Cordylanthus mollis* ssp. *mollis* within its *historic range* will advance recovery of the species. Restoration efforts may take time to build higher *marsh* elevations used by the species. *Tidal marsh* restoration projects within the geographic range of *Cordylanthus mollis* ssp. *mollis* are likely to contribute significantly to its recovery after several decades. Introductions and *reintroductions* within the *historic range*, particularly around San Pablo Bay and associated marshes, to the westward extent of the known range, should be pursued where and as soon as conditions are appropriate. Introductions and *reintroductions* into larger or higher quality habitat areas in the Suisun Bay area will also help speed recovery of the species.

Some independent experimental efforts to translocate seed of *Cordylanthus mollis* ssp. *mollis* and initiate new colonies have been performed by the Contra Costa Mosquito Abatement District. These resulted in establishment of numerous new colonies in existing *brackish* marshes with *tidal* range restricted by adjustable tidegates along the Contra Costa shoreline. Some of these colonies have exhibited net *population* expansion and persisted for several years (K. Malamud-Roam pers. comm. 1998). No data are available on effects of seed translocation on parent *populations*. Artificial establishment of new *populations* is a potentially useful tool for recovery of this species, but it has limited conservation value unless it is linked with habitat protection and restoration. In 2000, Brenda Grewell reintroduced a *population* of *Cordylanthus mollis* ssp. *mollis* from seed on protected Solano Land Trust lands at Rush Ranch and this *population* remains today. Because the establishment of long-term *populations* is highly unpredictable, translocation for *mitigation* purposes (*i.e.,* replacement of established *populations* with experimentally established new ones) cannot be viewed as a conservation measure and is presumably detrimental to conservation (Berg 1996, Howald 1996).

Many of the most important *populations* of *Cordylanthus mollis* ssp. *mollis* occur in areas owned and protected by public agencies with conservation policies that benefit rare or endangered species: Fagan Slough Ecological Reserve, Hill Slough, Joice Island Bridge Marshes (California Department of Fish and Game); Rush Ranch (Solano Land Trust); Benicia State Recreation Area and Point Pinole (East Bay Regional Parks District). The Middle Point and Hasting Slough *populations* occur on federally-owned lands of the U.S. Navy and are therefore subject to the conservation obligations and prohibitions of the Endangered Species Act. These agencies, however, often lack the resources or mandate to manage these lands, and seldom have the resources or institutional priorities to enforce land use restrictions to protect or benefit *Cordylanthus mollis* ssp. *mollis*, or to monitor *populations* adequately.

The principal benefits to *Cordylanthus mollis* ssp. *mollis* from conservation activities are mostly indirect. The species is protected against filling and degradation of wetlands by general prohibitions and their effects on land use planning. The species also indirectly benefits from the prohibition against take of listed wildlife species (California clapper rail, salt marsh harvest mice), which has discouraged additional degradation of remnant *tidal* wetlands with suitable habitat for *Cordylanthus mollis* ssp. *mollis*.

3. *Suaeda californica* (California sea-blite)

Recovery of *Suaeda californica* has two principal components: 1) protection of the core *population* at Morro Bay to ensure its long-term survival, and 2) re-establishment of suitable habitat with new *populations* in San Francisco Bay, the historical range of the species. Implementation of all recovery tasks will allow the species to reproduce and establish in dynamic shoreline environments across its natural range.

Preventing extinction of the last wild natural *populations* in Morro Bay is the highest priority task. Public lands that support the species should be managed to reduce or eliminate threats to the *population* and to foster its natural regeneration. Management plans are needed at Montaña de Oro State Park (Morro Dunes Nature Preserve), which contains the largest block of habitat and has good potential for effective protection because of its relative inaccessibility. Smaller parcels, such as Sweet Springs Marsh in Baywood Park, also need to be managed to avoid losing colonies and habitat. The *populations* at the Morro Bay State Marina and the sandy shoreline between White Point and Fairbank Point require protection against grazing by deer, trampling, and future shoreline engineering.

Suaeda californica colonies occurring in artificially stabilized shorelines should be presumed important to the species. Impacts to existing *Suaeda californica* plants from unavoidable maintenance of existing facilities or uses must not jeopardize the species, and should be offset fully (preferably in advance, or else with adjustment for risks of failure and likely mortality) by removing threats and expanding *Suaeda californica populations* in restorable, preserved habitat. Some shallow dredging specifically to enhance eelgrass communities may be compatible with retaining *tidal marsh* in its current configuration.

Remaining undeveloped shoreline and an upland buffer zone should be protected from further encroachment or land use alteration, in potential and occupied habitat of *Suaeda californica*. For example, the *population* of *Suaeda californica* along the retreating beach shoreline between White Point and Fairbank Point (Morro Bay State Park) should be allowed to re-seed landward with the retreating shoreline and shoreline stabilization or development should be minimized there. *Suaeda californica* at Grassy Island should be protected against potential dredging activities. Where possible undeveloped private shoreline should be permanently protected by acquisition or conservation easement.

Along the bayshore of the Morro sandspit (Morro Dunes Natural Preserve, Montaña de Oro State Park) and elsewhere around Morro Bay, the habitat quality of the high *marsh* zone for *Suaeda californica* —particularly for seedling establishment—should be enhanced by control of *invasive non-native Carpobrotus edulis* (iceplant) and hybrids. Control of *Carpobrotus edulis* should extend in phases—first immediately around *Suaeda californica* plants, then throughout *Suaeda californica* potential habitat, then a buffer strip next to *tidal marsh*, then source areas for propagule sources (vegetative fragments from foredunes, seed sources from fruiting *populations* in stable dunes). *Carpobrotus edulis* control activities could have adverse impacts on the endangered Morro shoulderband snail (*Helminthoglypta walkeriana*; U.S. Fish and Wildlife Service 1994) and should be conducted iso that impacts are minimized and offset, for example,

by establishment of suitable native habitat. Any such work would need to be performed under the authority of a section 10 (a)(1)(A) permit for Morro shoulderband snail that includes habitat restoration as a covered activity. *Non-native* trees and shrubs also should be removed from the vicinity of *Suaeda californica* habitat, except at those sites used by herons, egrets, and cormorants as rookeries. (Rookeries cause tree dieback, and *Suaeda californica* is stimulated rather than injured by rates of guano deposition toxic to most other plants (P. Baye pers. comm. 2004).

Management of sand dunes upwind of areas inhabited by the species may be needed to control factors that affect survival and regeneration of *Suaeda californica*. Dune mobility should be monitored, especially where it has been artificially increased by human actions, such as deposition of dredge spoil. If dune drift threatens to eliminate important stands of *Suaeda californica,* it should be reduced, for example, by extensive replanting of native dune-stabilizing vegetation during years of above-average rainfall. Any future dredge disposal in the area should be planned to avoid unnatural dune drift onto *tidal marsh* habitat and to maximize nesting habitat of western snowy plover.

Areas of degraded habitat should be restored to encourage re-expansion of *Suaeda californica* colonies there. Experimental *augmentation* of *populations*, including initiation of new colonies in suitable unoccupied habitat, should be continued to assist in local recovery following natural declines in *population*. Continued propagation and planting of *Suaeda californica* is appropriate if monitoring indicates it remains successful and within ecologically appropriate bounds. Adequate propagation to allow for periodic translocation of *Suaeda californica* plantings to San Francisco Bay is desirable.

Research within the Morro Bay *population* of *Suaeda californica* is needed to determine those factors necessary for seed survival, germination and seedling establishment. Additional studies on the relative importance of impacts of grazing, trampling and disturbance there, such as from deer and recreational activities,and how to prevent or minimize impactsshould prove useful.

A *viable* set of *populations* of *Suaeda californica* in San Francisco Bay is necessary because 1) survival of the species is likely to depend on more than one geographically distinct *population*, each with independent risks of extirpation, and 2) continued evolution of the species in its full natural range of environmental variability must be restored to ensure long-term survival. The major historical habitat for *Suaeda californica* in San Francisco Bay was the Oakland-Alameda sand-edged marshes, which have been destroyed and cannot be restored due to intensive urban land use. Recovery of the species in this urbanized *estuary* will depend on 1) establishment of local *populations* in pocket *tidal* marshes with sand or shell *beach ridges* formed spontaneously along artificially modified bay shorelines, 2) ecological engineering of new sand *spits* and *backbarrier* salt marshes in suitable environments in the vicinity of historical localities, and 3) introduction and *reintroduction* to suitable unoccupied habitat. Cooperation of land managers and adjacent landowners, and preparation and implementation of scientifically sound introduction ,*reintroduction* and management plans, will be essential to the recovery of *Suaeda californica* in San Francisco Bay.

In San Francisco Bay, the Baylands Ecosystem Habitat Goals report (Goals Project 1999), a comprehensive overview of recommendations to restore wetlands in the San Francisco Bay Estuary, proposed specific objectives to restore suitable habitat and reintroduce *Suaeda californica* to selected shorelines of San Francisco Bay. A pilot *reintroduction* project for the species, jointly managed by the National Park Service (Golden Gate National Recreation Area) and the non-profit Golden Gate National Parks Association, restored a small-scale *barrier beach* and salt *marsh* at Crissy Field in the Presidio of San Francisco (Farrell and Heimbinder 2000). Successful techniques for vegetative and seed propagation of *Suaeda californica* were developed at Strybing Arboretum and Botanical Garden, San Francisco, and at the Golden Gate National Recreation Area's two native plant nurseries at the Presidio and Fort Cronkite.

Initial *reintroductions* of *Suaeda californica* to Crissy Field in the Presidio failed because of prolonged periods of non-*tidal* submergence along *lagoon* shorelines where it was transplanted by the National Park Service (NPS; in coordination with U.S. Fish and Wildlife Service) in 2000. The National Park Service provided excess propagation material of *Suaeda californica* to Heron's Head *marsh* restoration (Pier 98, near a long-*extirpated* locality of *Suaeda californica*), but transplants declined because of unsuitable substrate conditions. Seed dispersal from Heron's Head transplants, however, resulted in successful spontaneous seedling establishment of *Suaeda californica* on a low, naturally formed shell and sand *beach ridge* with sparse salt *marsh* vegetation (pickleweed, saltgrass, alkali-heath) elsewhere at Pier 98. The new Pier 98 *colony* now consists of very robust, vigorous plants with abundant production of *viable* seed (P. Baye pers. comm. 2007). The spontaneous spread and high vigor of the Pier 98 *population*, in the absence of any management at all, suggested a high feasibility for successful deliberate *reintroduction* of *Suaeda californica* in suitable, dynamic high sandy *marsh* habitats along other urban shorelines of San Francisco Bay.

In 2006, under contract with the U.S. Fish and Wildlife Service, Peter Baye completed the *California Sea-blite (Suaeda californica) Reintroduction Plan, San Francisco Bay, California*. This document investigated and ranked the suitability of various potential *Suaeda californica reintroduction* sites around San Francisco Bay. Candidate sites were evaluated in terms of indicators of physical shoreline structure and dynamics (beach profile, wave climate, erosion/*accretion*, shoreline stability, *tidal* litter characteristics), *invasive* shoreline vegetation, land ownership and use (compatibility, management feasibility), and *population* potential. In the document, four San Francisco Bay sites were considered highly feasible for *reintroduction* in near-term planning (one to three years): (1) Roberts Landing Beach (San Leandro); (2) Radio Point Beach *marsh* complex at Emeryville Crescent *tidal* flats (Oakland Bay Bridge approach, north shore), (3) Eastshore State Park beach, Berkeley; (4) Brisbane spit (bayshore gravel/shell spit south of Candlestick Point). *Reintroduction* plans for these sites are proposed.

The contract also provided funds for on-the-ground *reintroduction* at sites identified in the *California Sea-blite (Suaeda californica) Reintroduction Plan, San Francisco Bay, California* if landowner permission for *reintroduction* was granted. In March 2007, 14 transplants were introduced along the high *tide* line in the northeast portion of the Emeryville Crescent, Alameda County, portion of Eastshore State Park managed by East Bay Regional Park District, a regional recreation district. A monitoring visit in April of the same year revealed the mortality of only four transplants, presumably from moisture deficit, as no significant rain fell the week after

tranplanting. The remaining ten plants, however, were healthy and thriving. At least several plants had moderate to heavy seed production that initial year. The purpose of this specific *reintroduction* at Emeryville Crescent was to reintroduce self-regenerating *populations* of the species in suitable habitat that does not require intensive management.

The project was designed to utilize volunteers from the general public and non-profit conservation organizations to conduct annual monitoring and light maintenance activities. The U.S. Fish and Wildlife Service expects this demonstration project to provide scientifically sound evidence of *reintroduction* success with *Suaeda californica* in San Francisco Bay through a highly cost-effective program and method capable of replication at other sites. In fact, a second *reintroduction* was conducted in March 2008 at Robert's Landing. It is too soon to determine whether these eight plants, which exist on City of San Leandro lands, will be self-sustaining.

A major goal of these *founder populations* in San Francisco Bay is to produce seed and spontaneously establish seedlings subject to natural selection in San Francisco habitats. The reintroduced *founder populations* were composed of clones or seedlings sampled throughout the Morro Bay area to increase *genetic* variation. Plants were propagated with permanently labeled stock plants (clonal pedigrees) to prevent over-representation of a few *genetic individual*s. Additional individuals were added to compensate for loss of *founders* and to offset limited initial *founder population* size. Propogated and transplanted individuals will not be counted toward recovery of the species because they do not reflect natural *population* or evolutionary processes. Experimentally reintroduced *populations* will only contribute toward recovery, as indicated in the recovery criteria, when plants produce seed which germinates and grows at the site over multiple generations . Long-term monitoring, education, and *stewardship* programs for *Suaeda californica* should generate public interest and support for further habitat restoration and rare plant species *reintroduction* in San Francisco Bay.

Considerable research is likely to be needed on *Suaeda* in San Francisco Bay, including best techniques for establishing and maintaining the species and methods for restoring or re-creating appropriate habitat. Understanding of dispersal and colonization patterns and the importance of various factors affecting them will also be useful, as will *population demography*.

Morro Bay State Park currently provides no programs to control exotic vegetation where it interferes with growth and reproduction of *Suaeda californica*. Local municipal salt *marsh* parcels in the residential Baywood Park do have some public education signs and voluntary restrictions on *marsh* access, which benefit some colonies. Two parcels have recently entered into conservation ownership: California Department of Parks and Recreation recently acquired a 19 acre parcel at the western terminus of Butte Drive near Los Osos and Morro Bay Audubon Society acquired a 12 acre parcel of habitat contiguous with Sweet Springs Nature Reserve, also near Los Osos (J. Vanderweir pers. comm. 2009). With few exceptions, there are currently no other major proposals or plans to manage or conserve *Suaeda californica populations* in Morro Bay.

4. California clapper rail (*Rallus longirostrus obsoletus*)

A number of State and Federal statutes were employed over the last 15 years to protect California clapper rails. For example, in 1991, the Regional Water Quality Control Board, under provisions of the State's Porter Cologne Water Quality Act and section 402 of the Federal Clean Water Act, required about 385 acres of full replacement for habitat values and acreage lost due to conversion of approximately 270 acres from salt *marsh* to fresh/*brackish marsh* in south San Francisco Bay from the City of San Jose waste water discharge. Under the provisions of section 7 of the Endangered Species Act and section 404 of the Clean Water Act, the U.S. Fish and Wildlife Service and U. S. Army Corps of Engineers have protected California clapper rail habitat from a variety of potential impacts or threats, including utilities and transportation incursions, flood control dredging, *levee* maintenance and several proposed commercial developments (*e.g.*, Cullinan Ranch and Shorelands).

Recovery of California clapper rails requires a combination of interim and long-term actions. Interim actions are those necessary to maintain current *populations* while long-term actions focus on recovering the species throughout its range. Interim actions involve monitoring current *populations* (number and distribution), *non-native* predator and *invasive* plant control, reducing human disturbance and protection of existing habitat. Long-term actions involve large-scale *tidal marsh* restoration and implementation of long-term management plans.

Habitat Acquisition

Acquisition efforts for the California clapper rail aim to provide or protect lands that can be used to create and expand clapper rail habitat. Recent habitat acquisition efforts focus on acquiring remaining *tidal marsh*, salt ponds, and other historic baylands and adjacent *uplands* in the San Francisco Bay Estuary. Acquisition in the San Francisco Bay Estuary as a whole focuses on *diked* baylands that can be restored to *tidal* influence, which is critical for providing lands for future *tidal marsh* restoration.

In March 2003, 16,500 acres of salt ponds were sold by Cargill Corporation to California Department of Fish and Game and the U.S. Fish and Wildlife Service for *tidal* restoration. If successful, the restoration could be the single most significant step toward California clapper rail and salt *marsh* harvest mouse recovery. The acquisition, which included approximately 1,500 acres of salt ponds in the Napa River watershed and approximately 15,000 acres of salt ponds in the South Bay (specifically at the Baumberg [Eden Landing], Alviso, and Ravenswood areas), will enable the largest *tidal* restoration project in west coast history.

The vision of restoration of a significant portion of the Bay's *tidal marsh* was first articulated by the Bayland Ecosystem Goals Project and is currently the subject of a large restoration planning effort, the South Bay Salt Pond Restoration Project. The former commercial salt ponds are slated for phased restoration as a mosaic of *tidal* salt *marsh* and non*tidal* managed ponds. The Final EIR/EIS for the South Bay Salt Pond Restoration Project was published on December 12, 2007.

The Baumberg site, formerly proposed as a racetrack and park complex (Shorelands), is a key site now protected in San Francisco Bay. This site, owned and managed by California

Department of Fish and Game, will add significant high quality habitat for *tidal* species as well as many species of shorebirds. While the final habitat acreage suitable for restoration to salt *marsh* habitat is yet to be determined, thousands of acres of suitable habitat for *tidal marsh* species may eventually be enhanced or restored, and existing *populations* protected. Similar phased restoration is planned for pond complexes at Alviso and Ravenswood areas, which will be owned and managed by the Don Edwards San Francisco Bay National Widlife refuge.

Other major acquisitions where salt *marsh* restoration has or will soon occur to benefit clapper rails include Cullinan Ranch (1,600 acres), Hamilton Army Airfield (900 acres), Bel Marin Keys Unit V (1,600 acres), Skaggs Island Naval Reserve (3,000 acres), Bair Island (1,400 acres), Baumberg Tract (835 acres), Oro Loma Marsh (Marathon property, 325 acres), Sonoma baylands (300 acres), and the Napa Marsh salt ponds (over 8,000 acres). This represents a major increase in habitat acquisition for clapper rail recovery since the 1984 recovery plan (U.S. Fish and Wildlife Service 1984). However, full recovery of the California clapper rail still requires a substantial decrease in the amount of baylands currently used for commercial salt production.

Habitat Restoration

Habitat restoration projects that include the *reintroduction* of *tidal* influence to many sites in the bay will provide benefit for the California clapper rail. Restoration sites in the South Bay include the Faber Tract, Outer Bair Island, Hayward Shoreline, LaRiviere Marsh, the Island Ponds, and East Third Avenue. In the North Bay, restorations have included a portion of Muzzi Marsh, Toy Marsh, Carl's Marsh, Tolay Creek, Sonoma Baylands, and White Slough. These restorations have occurred by natural *levee* breaching, enhancement projects, or as *mitigation* to offset the impacts of commercial development. Other *tidal marsh* restoration projects have not been successful in establishing suitable clapper rail habitat, for example, Warm Springs restoration in Fremont, New Alameda Creek salt pond restoration, the majority of Muzzi Marsh, and Bel Marin Keys *mitigation* on Tubbs Island.

Long-term recovery actions should focus on increasing habitat suitability and abundance in an appropriate distributional pattern. The California clapper rail cannot be recovered simply through protection of habitat currently available. Active management and restoration of *diked* marshes is required. Large blocks of *tidal marsh* have numerous advantages and must be restored and maintained in perpetuity to ensure the continued existence of these birds. First, large marshes increase distances from upland predator den/nest sites and impede foraging efficiency of terrestrial predators. This reduces predation pressure on California clapper rail adults, chicks, and eggs. Secondly, large areas of *marsh* have fewer urban *edge effects*, including human-related disturbance, contaminant inputs, and litter and subsequent attraction of rodent predators. Thirdly, the size and complexity of *tidal slough* networks increases as *marsh* size increases (Collins *et al.* 1994). A complex network of *tidal sloughs* provides the combination of foraging habitat and cover required by clapper rails. In addition, as the order of *tidal slough* increases (from primary to tertiary and higher, or as one travels farther into the *marsh* from the bay), the elevation of *marsh* increases. This means that elevation-dependent nesting areas and high *tide refugia* are more prevalent in large *marsh*es. Large-scale restoration projects are also more efficient compared to smaller, piecemeal efforts in terms of construction activities and management and will yield larger net benefits to clapper rails.

Key elements that will determine the suitability of each habitat block for clapper rails include vegetation structure (height and thickness relative to *tide* height) sufficient for nesting, brooding, and loafing; channel structure sufficient for feeding and protected movement throughout the *marsh*; and high *tide refugia* and transitional areas. First priority for acquisition/restoration of baylands are those areas with the best quality habitat and the most rapid restoration potential relative to the amount of time and effort invested. Habitat acquisition/restoration efforts should first build suitable habitat around existing *populations* and then provide links between these areas. Areas nearest to large rail *populations*/habitat blocks, under the least pressure from *non-native* species (especially *Spartina* and red fox), and least subsided or with the highest natural sedimentation rates, are included as first priority for acquisition/restoration to *tidal marsh*. In situations when dredge spoils become available for use in restoration, these priorities may shift slightly in placing a heavier emphasis on restoration in close physical proximity.

In addition, links must be maintained throughout the bay to facilitate dispersal and gene flow among sub*populations*. These links should be in the form of smaller units of managed and protected *tidal marsh* located between two or more larger areas each capable of sustaining clapper rails over the long-term. Dispersal facilitates exchange of *genetic* material among sub*populations* (outbreeding) and promotes recolonization of any sites that experience declines or local extirpation. *Population* increases for the rail must be distributed first throughout San Francisco Bay, and then throughout most of the formerly occupied coastal areas. Clapper rail reoccupation of historical range will diffuse the risk of *catastrophic* extinction resulting from events such as disease, predator outbreaks, and oil spills. Stable *populations* in independent estuaries will act as multiple *refugia* and survival insurance for the species as a whole. In addition, multiple *populations* in independent estuaries will allow for potential differentiation of *populations* and continuing evolution.

Existing *tidal* marshes that must be protected and/or enhanced include those north of Roberts Landing, north of Hayward Landing, north of Johnson Landing, the Hayward Area Recreation District Marsh, Alameda Creek, San Francisco National Wildlife Refuge lands, Coyote Creek, Laumeister Marsh, Greco Island, Bair Island, Colma Creek, Steinberger Slough, and Belmont Slough; Corte Madera, Muzzi and Heerdt Marshes, Arrowhead Marsh, Crescent Marsh, Wildcat Marsh, and Point Pinole; China Camp, Hamilton, Petaluma River and baylands, Tolay Creek, Sonoma Creek, Mare Island, and Napa River; Benicia State Recreation Area (Southampton marsh), Bahia (Solano County), Goodyear Slough, Browns Island, Martinez East, Martinez West, Concord Naval Weapons Station, Point Edith, and Pacheco Creek; Mud River Slough, Indian Island, Daby Island, and Teal Island; Bodega Bay, Tomales Bay, Bolinas Lagoon, and Drake's Estero; Elkhorn Slough Estuarine Sanctuary and Moss Landing.

Establishing *founder populations* at the northern and southern extremes of the rail's *historic range* by way of translocation is not considered a *viable* recovery strategy at this time. Reliable translocation techniques and success criteria which would be critical to this endeavor have not been developed. Survival of adults has been identified as a key variable in maintaining clapper rail *populations*, so capture and translocation of the species without the benefit of proven techniques would be risky.

The expanding salt *marsh* of the delta of Chorro and Los Osos creeks in Morro Bay contains *tidal* creek networks which may be, or may become, structurally suitable for clapper rails. A study may be needed of whether adequate foraging habitat and high *tide* refugial areas exist or could be restored to support the species. If California clapper rail *populations* in San Francisco Bay increase to sizes and densities that promote significant emigration of vagrants, they may wander to or recolonize Morro Bay. *Tidal marsh* and *tidal* creek networks there should be conserved to allow for such range re-expansion.

Management

In the San Francisco Bay region and southern California, management of clapper rails in recent years has focused on controlling introduced *non-native* predators, increasing habitat availability, and improving habitat quality. Continued *non-native* predator control in south San Francisco Bay, and expanded efforts in north San Francisco Bay (San Pablo Bay and Suisun Marsh area included), are necessary to protect current California clapper rail *populations*. The impact of *non-native* predators, particularly red fox, on clapper rails is well documented in San Francisco Bay and elsewhere (Roberson 1993, Albertson 1995, Harding *et al.* 1998). Management resources should be dedicated to continued and expanded predator control to reduce clapper rail loss and facilitate efforts to increase rail numbers and expand their range.

An integrated predator management program aimed at red fox, rats, skunks, raccoons, and feral cats was implemented at Don Edwards San Francisco Bay National Wildlife Refuge and adjacent areas in 1991 (U.S. Fish and Wildlife Service 1991). The Refuge evaluated the efficacy of its predator control program over 5 years and found that between 50-70 percent of the adult predator *population*, and 25-50 percent of the juvenile predator *population*, were removed annually (Harding *et al.* 1998). There was a positive relationship between the growth rate of clapper rail *populations* and red fox trapping success in the preceding year, which indicates that rail *populations* were depressed in areas with high numbers of red fox. In addition to trapping and removal, predator control has been achieved through debris removal, removing potential den sites, discouraging feeding of feral cats near marshes, and through public education.

Increasing habitat availability has been accomplished by restoring the full *tidal prisms* and lowering *dikes* in many areas of restoration projects. A full *tidal prism* ensures that sufficient channel flushing occurs to prevent excessive *sediment* deposition and subsequent channel infill, thus maintaining *slough* channels in perpetuity. Reducing the elevation of *dikes* in restored marshes to mean high water or mean higher high water and disrupting their contiguity (*dike* islands) will greatly decrease their use by predators for movement *corridors* and nesting/denning. In addition, the lowered, predator-free *dikes* and *dike* islands may provide relatively elevated areas that function as high *tide refugia* for clapper rails.

Improving habitat quality has also been a management focus, via *non-native* species control programs, habitat enhancement projects, and human disturbance reduction. The Invasive Spartina Project and the Don Edwards San Francisco Bay National Wildlife Refuge have led an aggressive control effort against *non-native Spartina* species. Immediate control of *non-native Spartina* is crucial for the protection of California clapper rail habitat. A delay in control efforts may have dramatic impacts on *tidal* marshes throughout the bay, as these plant species are extremely prolific, poised to explode in distribution, and are proving difficult to remove once

established. While control of other *non-native* plants is no less important, it is less time-critical. A number of Federal, State and local agencies and individuals have been monitoring the progress of *non-native Spartina* invasion, and a few agencies have been attempting to control/eradicate the species on their holdings. Management resources from every level (Federal, State, and local) should remain dedicated to *non-native Spartina* control.

Many of the restoration projects also include management plans to control or eliminate *non-native Lepidium latifolium* and other *invasive* plant species. The Refuge removed artificial raptor perches (posts and stakes) from most of their property in the South Bay, enhancing habitat quality for rails by reducing predation pressure. *Marsh* managers also worked to reduce disturbance to rails resulting from recreational use of marshes, including off-trail activities, noise, and off-leash pets. These efforts should be continued and incorporated into management plans for future *marsh* restoration projects throughout the bay.

Surveys

Annual clapper rail monitoring should continue on Don Edwards San Francisco Bay National Wildlife Refuge, and expand to other Federal and State owned lands. Monitoring provides data that are useful both in the short-term for adaptive management of existing *tidal marsh*, and in the long-term to determine success of recovery efforts. In addition to annual monitoring conducted throughout the current range of the rails, intensive monitoring should be conducted at the edges of the current range, particularly in Suisun and Tomales bays. As recovery efforts proceed, California clapper rail *population* distribution will expand. Intensive monitoring will be necessary to document the resulting range expansion.

Research

Prior to the late 1980s, research on California clapper rails was limited to basic life history studies (*e.g.,* Degroot 1927, Applegarth 1938), *population* surveys and censuses (Gill 1972, Harvey 1980), and nesting success studies in localized areas (Harvey 1980). More recently studies by the Environmental Contaminants Division of the U.S. Fish and Wildlife Service and the U.S. Geological Survey have revealed elevated levels of selenium and mercury in fail-to-hatch rail eggs, lowered nesting success due to predation, and declining rail *populations* in the South Bay (Foerster 1989, Lonzarich *et al.* 1992, Schwarzbach *et al.* 2001, Schwarzbach *et al*. 2006). A radiotelemetry study was conducted by the U.S. Fish and Wildlife Service in 1991-92, investigating home range size and the impacts of predation on rails in the South Bay (Albertson 1995). The California Department of Fish and Game has funded studies on breeding *populations* and habitat use in the North Bay (Evens and Collins 1992, Collins *et al.* 1994). Other studies being initiated include *Spartina alterniflora* use by rails (Casazza *et. al.* 2008, Casazza *in litt.* 2009), *population genetics* (R. Fleischer unpubl. data), and *population* modeling (M. Johnson unpubl. data). Annual winter and breeding surveys are conducted in selected areas (U.S. Fish and Wildlife Service unpubl. data).

Further research is needed on clapper rail fledge success, adult survival, and dispersal. An assessment of the remaining *genetic* diversity of California clapper rails is needed, including comparisons between different reaches of the bay. Continued assessment of clapper rail *population* status and research on *population* dynamics are essential for predicting potential colonization rates of restored marshes. To accomplish this, there needs to be a better

understanding of subadult clapper rail survival, subadult and adult dispersal rates among marshes and bay reaches, and relationships between dispersal rates and inter-marsh distances and other environmental factors. Development of clapper rail *population* models that incorporate meta-*population* dynamics would facilitate these efforts and also aid in potential future translocation efforts. In 2008, the U.S. Fish and Wildlife Service provided funding to the U.S. Geological Survey to continue home range studies of California clapper rails using radio-telemetry in three San Francisco Bay marshes. These studies had initially been funded by the Invasive Spartina Project to determine effects of *invasive* Spartina control on California clapper rails. Later in 2008, the U.S. Geological Survey was awarded additional funding to add a diet analysis component of the project, focusing on identification of contaminated prey items.

Hatchability of California clapper rail eggs in San Francisco Bay has been shown to be low (Schwarzbach *et. al.* 2006). Previous studies have suggested that environmental contaminants, primarily mercury, are a contributing factor. PCBs and dioxins have not been ruled out, however, and more research is needed using congener specific techniques to assess their contributions to embryo toxicity. The sensitivity of California clapper rails to mercury and other contaminants prevalent throughout the bay is not known and currently may only be estimated based on toxicity tests on species from other families (*e.g.* Phasianidae). Toxicity tests and studies with similar species such as the non-endangered east coast rails (*Rallus longirostris crepitans* or *Rallus elegans*) may provide a better idea of the relative sensitivity of rails to contaminants compared to standard test species.

Perhaps more important in the long term, is research on wetland restoration techniques and design efficacy, and contaminant concentrations in wetland *sediments* (especially methylmercury production). The ramifications of failed *tidal marsh* restoration are large and long-term due to the large number (and large total acreage) of restoration projects that are currently in various stages of planning and implementation.

Outreach and education
Public information and education programs about the habitat needs of clapper rails, and the function and value of intact *tidal* marshes, should be expanded. To assure protection and management of key areas, participation plans should be in place among cooperating agencies, landowners, and conservation organizations.

5. Salt marsh harvest mouse (*Reithrodontomys raviventris*)

Past Conservation/Restoration
Numerous conservation measures that benefit the salt marsh harvest mouse directly or indirectly have been implemented since the publication of the 1984 recovery plan. The most ecologically significant conservation actions have been habitat protection, enhancement, and restoration. Beneficial habitat modifications have been performed both for their own sake and as *mitigation* for authorized actions that harm salt marsh harvest mouse *populations* and habitat.

Several critical sites in the range of the southern subspecies proposed for full development in the 1980s were modified significantly to minimize areas and impacts in salt marsh harvest mouse habitat and to provide habitat protection and enhancement over the remaining habitat. This

resulted in net benefits to the *population*. Outstanding examples are Roberts Landing (Citation Homes, San Leandro) and Mayhews Landing (Newark). In both these sites, the majority of habitat was protected and enhanced by re-engineered tidegates to improve *salinity* and moisture of salt *marsh*, while providing *tidal* drainage to prevent prolonged impounding of flood waters. These restorations have not been free of management problems, but the key habitats and *populations* are substantially improved in terms of security and quality. Monitoring and reporting requirements of project permits, however, were limited, so the long-term ecological and *population* trends of these sites will be difficult to determine.

The 16,500 acre salt pond purchase by California Department of Fish and Game and U.S. Fish and Wildlife Service from Cargill Corporation in March 2003, as described above, could be the single most significant step toward California clapper rail and salt marsh harvest mouse recovery. The Baumberg site, to be owned and managed by California Department of Fish and Game, will add significant high quality habitat for *tidal* species as well as many species of shorebirds. Thousands of acres of suitable habitat for *tidal marsh* species may eventually be enhanced or restored, and existing *populations* protected. Similar phased restoration is planned for pond complexes at Alviso and Ravenswood areas, which will be owned and managed by the Don Edwards San Francisco National Wildlife refuge.

The engineered salt *marsh* restoration at Pond 3 (Alameda Creek) is among the oldest in San Francisco Bay, constructed by the U.S. Army Corps of Engineers using dredged materials from the adjacent flood control channel. Although the project had some unanticipated and somewhat undesirable outcomes (spread of introduced *non-native Spartina alterniflora*, overfilling of dredged *sediment*), it has resulted in a large, high-elevation tidally influenced *Sarcocornia marsh* and an expanded *population* of salt marsh harvest mice. The *marsh*, however, has been only trapped twice, once in 1984 and again in 1985; capture efficiencies were 1.75 and 1.5 percent respectively, considerably below the 2.355 percent average for all projects. The overfilling of the site above design criteria minimized clapper rail habitat, but provided exceptionally thick *Sarcocornia* habitat that should be well buffered against rise in sea level, providing a major refuge for the species in a subregion where its *populations* and stable high-quality habitats are scarce.

Two other critical habitat sites for the southern subspecies, New Chicago Marsh (Alviso) and Renzel Marsh (ITT Marsh, Palo Alto) have been acquired and protected for wildlife, with high management priority for the salt marsh harvest mouse. The Renzel Marsh was protected and enhanced as *mitigation* for wastewater impacts (*brackish marsh* conversion) in Palo Alto, and New Chicago Marsh was acquired as an addition to the San Francisco Bay National Wildlife Refuge (Refuge). These marshes were re-engineered with tidegates to minimize the impoundment of floodwater and hasten flood drainage and to provide limited, managed *tidal* flows to enhance *Sarcocornia* habitat. They have succeeded in increasing the quality and abundance of *Sarcocornia* habitat, but water management will require ongoing adjustment (Woodward-Clyde 1996, Shellhammer pers. comm. 1998). In addition, as part of the asbestos removal program in that vicinity, the flood tidegates at New Chicago Marsh have since been removed and the responsibility for alleviation of *marsh* flooding lies jointly with the City of San Jose and the Refuge. The City pumps water out of New Chicago Marsh only during extreme high water events using the facilities at the Alviso pump station (Duke pers. comm. 2005).

These facilities are only designed to begin pumping when the water is extremely high in the *marsh*, so the Refuge is responsible for preventing the water from reaching this stage. Current Refuge outflow pumps were not designed to handle this volume of water, so the Refuge has had to rent pumps on several occasions. The Refuge is planning to improve water inflow and outflow structures to allow better water management in the *marsh* to enhance mouse habitat and to prevent excessive flooding (Albertson *in litt.* 2009).

One south San Francisco Bay *mitigation* site, the engineered *Sarcocornia* "mouse pasture" at Bayside Business Park at Warm Springs (Fremont), has been colonized by a continually low *population* of salt marsh harvest mice. The adjacent Bayside Business Park II development nearer Dixon Landing Road on Coyote Creek was reduced in size from its original footprint to minimize urban fill in *Sarcocornia* habitat. It is engaged in a long-term, phased conversion from *diked*, non-*tidal Sarcocornia* /salt pan habitat subsided well below sea level, to a *tidal marsh* with a wide, sloping, high *tidal brackish marsh* zone along the landward edge (U.S. Fish and Wildlife Service *in litt* 1996). Both sites are small and relatively isolated and the long-term outcome of this habitat restoration remains to be seen.

Other sites subject to *mitigation* have less auspicious results for recovery of the salt *marsh* harvest mouse. The large saline field adjacent to Mayhews Landing (former Jarvis Avenue) in Newark with sparse, but restorable, salt marsh harvest mouse *population* and habitat was almost completely developed as a business park in the mid-1990s leaving a highly reduced engineered flood detention basin with restricted *tidal* flows in a highly reduced area of salt *marsh*. It is unclear whether this habitat will sustain a *viable population* of salt marsh harvest mice, or whether it will act as a dispersal sink for adjacent habitats in the San Francisco Bay National Wildlife Refuge and Mayhews Landing.

Two highly important sites in San Pablo Bay have improved the status of the northern subspecies. The *diked* salt marshes south of Black John Slough along the lower Petaluma River were formerly proposed as an expansion of the Bahia residential development in Novato. This salt *marsh* has been acquired by the California Department of Fish and Game and is proposed to have tidegates repaired to prevent excessive impoundment of floodwaters in *diked* salt *marsh*. Work has recently been done at the Bahia Unit of the California Department of Fish and Game's Petaluma Marshes Wildlife Area to remove an obsolete agricultural water pump, lower some levees, and create several new water control structures, channels and berms (Huffman *in litt*. 2009). All of this work was done by the California Department of Fish and Game, in coordination with the Marin and Sonoma County Mosquito Abatement Districts, to improve water quality and circulation within the unit (Huffman *in litt.* 2009). This is a very significant core *population* in the Petaluma Marsh. Secondly, as *mitigation* for a median barrier/shoulder widening project along the highway, the California Department of Transportation (Caltrans) engineered flood drainage enhancements to the Highway 37/Mare Island strip *marsh*, the eastern half of which suffered flooding and drainage problems caused by the intake canal *berm*. The project resulted in rapid *sediment accretion* and decreased the depth and duration of flooding from *storm surges* and rain. The project would have restored 1,600 acres to highly valued *tidal marsh* habitat. However, though initially successful, infilling and waves eventually re-built the *berm* and the added drainage was lost after approximately 6 years (P. Baye pers. comm. 2007).

Another major *tidal* drainage enhancement project that reduced persistent storm-tide flooding of salt marsh harvest mouse habitat is located in San Pablo Bay at the mouth of Tolay Creek in the San Pablo Bay National Wildlife Refuge. This was completed in 1999 and is being monitored for the Refuge.

Management of habitat in Suisun Marsh favorable for salt marsh harvest mice has been minimal in the past, and compensation requirements for the northern subspecies in the subregion from the 1980s were not met in a timely manner. In 2000, a collaborative program established by the California Department of Water Resources, the California Department of Fish and Game, and an *ad hoc* interagency group, the Suisun Marsh Environmental Coordination Advisory Team, established an action program to fulfill and exceed delinquent monitoring and compensation requirements. The implementation of this program should establish 2,500 acres of preferred salt marsh harvest mouse habitat (California Department of Fish and Game *in litt.* 2000). CALFED's goals for ecological restoration in Suisun Marsh were revised to 7,000 acres of *tidal marsh* restoration in Suisun Marsh (M. Thabault pers. comm. 2001). By 2009 three *tidal marsh* restoration projects were either fully or partially CALFED-funded and are in some phase of development (Blacklock, Meins Landing, and Hill Slough). *Levees* have already been breached at Blacklock and Meins Landing projects, lead by California Department of Water Resources. Restoration at Hill Slough by California Department of Fish and Game is currently on hold pending availability of funds (Barthman-Thompson *in litt*. 2009). The Montezuma Wetland Project near Collinsville has not been completed, but it contributed precedent-setting and thorough habitat restoration designs that included interim management to conserve resident *populations* of salt marsh harvest mice in *diked* wetlands, and engineered high *marsh* habitat to facilitate early recolonization by the species.

Much of the variation in morphology and color among harvest mouse *populations* is quantitative, and traits of individual specimens may overlap. To improve consistency, standardized trait-scores for key harvest mouse morphological variables have been developed (Shellhammer 1984). *Intergrades* between western harvest mice and salt marsh harvest mice have become more common in trapping surveys (Zetterquist 1976, Steinberg 1997). It is not known whether intermediate *populations* are the result of hybridization, the convergence of western harvest mouse *populations* that invade salt *marsh* habitats and evolve traits typical of salt marsh harvest mice, such as darker coloration (Steinberg 1997), or are a byproduct of the classification system of Shellhammer (1984) (*i.e.,* more animals score intermittent scores when trappers pick more intermediate scores for various tail traits and hence some animals that might be either salt marsh harvest mouse or western harvest mouse fall out as categorical but not necessarily biological "intermediates").

Current recovery strategy

The basic strategy for recovery of the salt marsh harvest mouse is the protection, enhancement, and restoration of extensive, well-distributed habitat suitable for the species. The specifics must be modified for the similar, but distinct, recovery needs of the two subspecies. There are short- and long-term components of the general recovery strategy as well as specific geographic elements. Both interim and long-term components are necessary; neither alone is sufficient to recover the salt marsh harvest mouse.

Management

An interim reserve system is needed to ensure the immediate survival of a minimum number of core *populations* of salt marsh harvest mice. These reserves should also provide sufficient numbers and variety of *founder populations* to expand and colonize new habitat for recovery in the long term. Large habitats and *populations*, selected to represent the full range of each subspecies, should receive the highest priority for protection, active management as needed, and monitoring, to minimize the risk of *population* declines or extirpation. Each core reserve should be supplemented with a series of smaller satellite reserves where feasible. Interim reserves may include both natural and artificial habitat, and must be maintained at least until large-scale *tidal marsh* restoration sites support well-established, resilient new *populations* of salt marsh harvest mice. The relative emphasis on *diked* salt *marsh* and *tidal*salt *marsh* as interim reserves will differ between San Francisco Bay and the rest of the *estuary*. *Populations* of the southern subspecies in San Francisco Bay must rely heavily on engineered, highly managed habitats, due to the unstable *populations* of salt marsh harvest mice in modern *tidal* salt *marsh*es there.

Currently, a large proportion of salt marsh harvest mice in Suisun Marsh are supported by *diked* wetlands on Grizzly Island. Because of this and because lands here are severely subsided and would be nearly impossible to restore to *tidal* conditions, *diked* wetland acreage may be substituted for *tidal marsh* habitat when meeting acreage-based recovery criteria within the Grizzly Island Marsh Complex only. *Diked* salt marshes, although important in the short-term for the survival of both subspecies, have numerous limitations. They require perpetual repair and maintenance. Because most are subsided below sea level, they remain subject to *catastrophic* flooding. They are also incompatible with the recovery of the other principal endangered *tidal marsh* species. The short-term predictability of habitat quality provided by *diked* managed salt *marsh* is offset by the cost and artificial nature of their ecosystems. This reliance on artificial habitats for recovery is inconsistent with Service policy regarding the ecosystem approach to recovery, which emphasizes the Endangered Species Act purpose of "conserving the ecosystems on which endangered species depend." The long-term liabilities of *diked* salt marshes can be addressed by a transition to habitat in restored or enhanced *tidal marsh* ecosystems.

Diked marshes maintained as interim reserves should be evaluated for conversion to *microtidal* salt or *brackish* marshes. These are better habitats for salt *marsh* harvest mice than non*tidal*salt marshes and are less susceptible to degradation. *Diked* non*tidal* salt marshes should be converted to *diked microtidal* marshes when 1) habitat conditions for the salt marsh harvest mouse are poor and would probably be improved by restricted *tidal* flows; 2) adequate access to *tidal* sources is feasible, and installation of tidegates and inlet channels would not cause excessive environmental impacts; and 3) site elevations relative to sea level are compatible with operation of tidegates with or without addition of dredge materials

Microtidal marsh salt marsh harvest mouse reserves in Suisun Marsh were successful from 2000 to 2005 in increasing salt marsh harvest mouse *populations* within them. Overall, however, *microtidal* marshes seem to be less important now than they once might have been, given the extent and distribution of existing and/or restorable *tidal* marshes. *Diked microtidal* marshes in subsided baylands are not appropriate substitutes for full *tidal marsh* because they require perpetual maintenance of *dikes*, ongoing tidegate adjustment, monitoring, maintenance and repair and cannot equilibrate with rising sea level. Consequently, they are vulnerable to more

severe, prolonged flooding than fully *tidal* marshes. These are poor prospects for long-term survival of salt marsh harvest mouse *populations*.

Habitat Restoration

In the long term, large-scale units of restored *tidal marsh* (thousands of acres) should be located around interim reserves. These *tidal* marshes will restore functional, resilient natural ecosystems for the continued survival of the salt marsh harvest mouse and avoid perpetual management of smaller habitats that are more vulnerable to *catastrophe* and extirpation. Restoration of *tidal* marshes must include foundations for large high *marsh* belts; wide, gently sloping gradients between mean higher high water; and local elevations of storm high *tide* lines (*driftlines*). Where possible, restoration of *tidal* marshes should proceed from baylands adjacent to core *populations*, and coalesce with one another to form extensive, contiguous habitats in large blocks, thus reversing fragmentation of habitats and *populations*.

Large-scale *tidal marsh* restoration is likely to take at least several decades, and likely as much as 50 years in deeply subsided areas, to reach the ecological maturity required for secure establishment of large, resilient *populations* of salt marsh harvest mice. Sea-level rise and declining *sediment* availability (Goals Project 1999) may retard the rate of *tidal marsh* succession in some or all parts of the *estuary*. The effects of *invasive non-native Spartina alterniflora* (smooth cordgrass) add unpredictability to the timing of restored salt marsh harvest mouse habitat. In addition, much of the potential large-scale *tidal marsh* restoration in south San Francisco Bay has complex engineering requirements (salt pond retrofitting, desalinization) that may take time to plan, design, and implement. In *brackish* Suisun Marsh, restoration of mature *tidal marsh* plains may take a very long time, and is likely to result in habitat that provides for low density of salt marsh harvest mice compared with the high density, but unstable, patches of *Sarcocornia* in *diked* marshes.

The long-term uncertainty regarding the timing of restored *tidal marsh* plains can be addressed by engineering foundations for wide high *tidal marsh* zones along the edges of perimeter *dikes*. These preconstructed *ecotones* between upper middle *marsh* zones and high *marsh* habitat (with *Grindelia* vegetation and trapped *tidal* debris as *tidal refugia*) can ensure a minimum of rapidly formed suitable habitat for recolonization by salt marsh harvest mice.

A recurrent dilemma for the recovery of salt marsh harvest mice is that restoration of *tidal* marshes is often accomplished by conversion of *diked* non*tidal* salt *marsh* currently occupied by salt marsh harvest mouse *populations*. Conversion of these subsided areas requires sedimentation to restore mature *marsh* plains, resulting in a prolonged period (at least a decade, but usually several) in which resident *populations* are displaced by uninhabitable aquatic habitats. Conservation of existing *populations* is important when the *populations* are large or isolated or are relicts in an area where most other *populations* are small, unstable, or at high risk of extirpation. The premium on conserving existing *populations* is lower where *tidal marsh* restoration sites contain very small, unstable *populations* in poor and declining habitat that lie adjacent to large areas of high quality habitat and significant *populations*. The goal is to conserve *founder populations* with adequate *genetic* diversity and initial numbers to persist over the long periods until restored *tidal* marshes are ripe for recolonization. In this way, essential

habitat restoration will, for many *marsh* species, including salt marsh harvest mouse, inevitably result in short-term losses for the benefit of long-term gains.

Unoccupied and unsuitable habitats are the highest priority for *tidal marsh* restoration, particularly when these sites are large and near existing *populations*. Some marginal habitats may be important as transient *refugia* where no alternative habitat exists, but may not be independently *viable* for conservation. Large marginal, unsustainable *diked* habitats should have a high priority for restoration where feasible. Potential *tidal marsh* restoration sites with large acreages of *Sarcocornia* habitat and salt marsh harvest mouse *populations*, in subregions where mouse *populations* have become scarce (*e.g.,* Montezuma wetlands, Bayside Business Park II), should generally be lower in priority for *tidal* restoration, or restoration should be implemented either in phases or after secure *populations* are established on-site or adjacent. These priorities will promote a regional pattern and sequence of *tidal marsh* restoration sites that maximizes long-term benefits to the species, and minimizes short-term impacts on *populations*. The unavoidable impacts to salt marsh harvest mice in *diked* baylands must be addressed at a subregional or regional scale.

Active translocation of live-trapped individuals should be considered only when no other practical alternatives are feasible, as the efficacy of this method has not yet been determined. Reliance on colonization by natural, long-distance dispersal of salt marsh harvest mice from remote habitats is less desirable than conservation of internal *founder populations* because it is improbable, unpredictable, and unreliable. Low initial *founder* numbers from long-distance dispersal would increase the risk of *founder population* failure, *inbreeding* depression, and *genetic* bottlenecks.

Tidal marsh restoration plans that require conservation of *founder populations* of salt marsh harvest mice must accomplish three basic tasks:

1) Interim management of habitat quality (vegetation, *salinity*, flooding, and drainage) in *diked* salt marshes to maintain any resident *populations* present while *tidal* restoration projects are planned;

2) Where proximity of existing strip marshes does not provide sufficient local sources of colonists, construction of temporary refuges to sustain ample resident *populations* that would otherwise risk extirpation during the period of site preparation and early phases; and,

3) Construction of directly adjacent suitable salt marsh harvest mouse habitat in high *tidal marsh* zones to serve as temporary refuges at the time *tidal* restoration is initiated. This will avoid a prolonged period during the early phases of restoration when habitat is deficient. This pioneer habitat may be identical to temporary refuges, extensions of them, or independent of them, depending on restoration logistics, but must be directly adjacent to avoid excessive predation of mice trying to reach the temporary refuges. Pre-construction of high *marsh* pioneer habitat involves grading wide gently sloping benches at and above the planned mean higher high water line at the restored *tidal marsh* edge, and temporarily cultivating *Sarcocornia* one to two years in advance of *tidal* restoration.

Many restoration projects being implemented in the bay area are designed with only general or superficial analysis of salt marsh harvest mouse requirements. Design teams for *marsh* restoration or enhancement projects should include qualified experts to provide restoration designs affecting salt marsh harvest mouse recovery. An interdisciplinary review panel, including experts in salt marsh harvest mouse ecology, salt *marsh* vegetation, and *hydrology* or *geomorphology* of estuarine marshes, should review *tidal marsh* restoration designs before they are funded for construction. The review panel should be supported collaboratively by willing Federal, State, and responsible local agencies with expertise and jurisdiction in the recovery of the salt marsh harvest mouse.

Surveys

The most important data/research need at present is to fill in gaps in understanding of the current distribution, density, and *demographics* of the salt marsh harvest mouse. Most records are greater than ten years old and no systematic surveys have been carried out in key areas. Expectations of salt marsh harvest mouse *population* expansion into restored marshes are dependent on the presence of extant *populations* adjacent to restoration areas that can serve as source *populations* of the mouse. Resources for salt marsh harvest mouse surveys should be shifted from site-specific presence/absence surveys, to systematic regional surveys with replicated sampling over time. Surveys should give special emphasis to building upon information gained after the 2005 floods by tracking salt marsh harvest mouse (and other small salt *marsh* mammal) *populations* before and several years after major flood events, comparing *population* regeneration and extinction probabilities for a range of habitat types, sizes, and landscape positions (location along *sloughs* or bays, distances from nearest known *populations* or habitats). Regional survey programs for both subspecies should be established and funded for a minimum of 10 years or one flood/drought cycle.

Research

Taxonomic research is needed to make field identification methods as accurate as possible as well as making them consistent with the true *genetic* identities of harvest mice in *brackish* and salt marshes. Molecular *genetic* research is needed to resolve the *genetic* identity of ambiguous (intergrade or intermediate) salt marsh and western harvest mice and to test whether actual hybridization or introgression has occurred. It is also very important to assess the amount of *genetic* variability within *populations*. Knowledge of *genetic* variation should guide the restoration process, helping us to identify which *populations* contain unique or rare *genetic* material. To prevent misidentification, diagnostic *genetic* markers are needed to verify the accuracy of field identification throughout the ranges of both salt marsh harvest mouse subspecies. Initial work on this is in progress at the California Polytechnic State University, San Luis Obispo by Francis Villablanca (Finfrock 2000).

Ecological studies should determine the conditions under which competition with other small mammals may have significant adverse effects on salt marsh harvest mouse *populations*. Environmental or *biotic* variables that affect *population* interactions between small salt *marsh* mammal species should be analyzed if significant species interactions are confirmed.

Combined studies of vegetation structure, plant community composition, and salt marsh harvest mouse live-trapping should be conducted over multiple years in all seasons at representative geographic subregions within the range of both subspecies. The interdisciplinary survey approach should determine the full range of salt marsh harvest mouse habitats and their ecological variations. These surveys should provide special emphasis on the ecology of salt marsh harvest mice in *Lepidium latifolium*.

Detailed *demographic* studies, including development of *population* models, may be useful for assessing the viability of isolated *populations*. *Demographic* and *population* modeling studies, however, should generally have lower priority than *population* studies that are directly applicable to enhancing and managing existing habitats and *populations* or to restoring habitats and re-establishing new *populations*. Specific *demographic* research is needed for habitat restoration design and management. Detailed telemetry studies should be applied to understand high *tide* movements of salt marsh harvest mice, both along landward *marsh* edges, bayward *marsh* edges, and deep within wide marshes. If translocation is proposed to minimize take, it should be preceded by experimental research using telemetry methods to determine the fate of both introduced and resident salt marsh harvest mice affected by translocation.

Outreach

Although the salt marsh harvest mouse is relatively well-known in the bay area, public understanding of its ecological needs should be improved. Age-appropriate educational materials should be prepared collaboratively by species experts and public educators, and distributed to public schools, university programs and environmental journalists. Public outreach materials should focus on the principal threats to the species (with emphasis on local conservation issues), recovery strategies and actions, and the results or progress of local recovery actions.

Geographic strategy

San Francisco Bay: Existing *tidal* marshes should be protected against filling and dredging impacts. The design of outboard *dikes* around the San Francisco Bay, and especially in southern areas where *subsidence* has taken place, merits reevaluation when they are replaced during *marsh* restorations. The outboard slope of such *dikes* in *marsh* restoration sites should be changed from the typical 1 to 1 slope at present to a 10 to 1 or greater slope, especially in areas of *subsidence* such as the southern end of the South San Francisco Bay. Such a change would allow for the correction of deficiencies in the distribution, abundance, and quality of high *tide* refugial habitat by establishment of an effectively wider high *marsh* zone as *marsh* restoration proceeds. Slopes of *dikes* in *microtidal* marshes should be similarly improved. Existing *diked* non*tidal*and *microtidal Sarcocornia* marshes should be protected and maintained or enhanced to improve the vegetation, *salinity*, and floodwater drainage. Wastewater discharges into South Bay *sloughs* should be reduced and discharged diffusely in *brackish microtidal lagoons* and *marsh* edges, rather than at point within *sloughs*. *Lepidium latifolium* should be eradicated along high *marsh* edges and *dikes*, and replaced with native vegetation suitable for these zones (primarily *Grindelia* and *Sarcocornia* below, and *Leymus triticoides* [creeping wildrye] above). *Tidal marsh* restoration should proceed with highest priority in baylands that are not strongly subsided and are not subject to high invasion pressure by *Spartina alterniflora.*

San Pablo Bay: Existing *tidal* marshes should be protected against filling and dredging impacts. Existing *diked* non*tidal* and *microtidal Sarcocornia* marshes should be protected and maintained or enhanced to improve *Sarcocornia* vegetation, *salinity*, and floodwater drainage. Artificial obstructions to lateral drainage of Highway 37 strip marshes should be removed to minimize flood duration and maintain extensive thick, tall *Sarcocornia* vegetation for the core *population*. *Lepidium latifolium* should be eradicated along high *marsh* edges and *dikes* and replaced with native vegetation suitable for these zones (primarily *Grindelia* and *Sarcocornia* below, and *Leymus triticoides* above). *Tidal marsh* restoration should proceed with highest priority in baylands that have not suffered strong *subsidence*, are closest to major *populations* of salt *marsh* harvest mice, and are major sources of *tidal sediments* and salts (adjacent to San Pablo Bay and the mouths of major rivers and *sloughs*).

Suisun Bay Area: Existing *tidal* marshes should be protected against filling and dredging impacts, adverse modifications of *tidal* circulation, and impacts on *tidal datums* and reduced *salinity* caused by *salinity* control gates. Management of waterfowl-priority *diked* marshes should be modified to be independent of *salinity* control gate operation in Montezuma Slough. Interim reserves of non-*tidal*habitat should be developed at locations in and around existing large patches of habitat with large *populations*. The locations of these sites may change with habitat conditions and require updating with surveys. Waterfowl-priority *diked* marshes should be re-engineered to increase compatibility with salt marsh harvest mouse *populations* by (1) converting many managed non-*tidal* waterfowl marshes to *microtidal* systems, including shallow *lagoons* and *brackish marsh* with high *Sarcocornia marsh* edges; and (2) modifying non-*tidal* flooding regimes to minimize submergence of *Sarcocornia marsh*; or (3) engineering unflooded benches or terraces along interior dike edges to maintain wide, minimally flooded, saline *Sarcocornia* marshes. Along the Contra Costa shoreline, existing *diked* non*tidal* and *microtidal Sarcocornia* marshes should be protected and maintained or enhanced to improve *Sarcocornia* vegetation, *salinity*, and floodwater drainage. *Lepidium latifolium* should be eradicated along high *marsh* edges and *dikes* in the region and replaced with native vegetation suitable for these zones (primarily *Grindelia* and *Sarcocornia* below, and *Leymus triticoides*, native *riparian* forbs, and shrubs above). *Tidal marsh* restoration should proceed with the highest priority in baylands closest to major *populations* of salt *marsh* harvest mice and major sources of *tidal sediments* and salts (adjacent to *mudflats* of Grizzly Bay, Suisun Bay, and Honker Bay *mudflats*, and mouths of major rivers and *sloughs*). High priority for *tidal marsh* restoration should also be assigned to *diked* baylands with potential for wide, gently sloping high *marsh ecotones*, regardless of position in subregional *salinity gradients*.

b. *Cordylanthus maritimus* ssp. *maritimus* (salt marsh bird's beak)

Cordylanthus maritimus ssp. *maritimus* has been mapped at Morro Bay. There are no other conservation efforts currently underway (M. Walgren *in litt.* 2006)

Conservation easements or fee-title purchase from willing sellers should be sought to place remaining undeveloped shoreline under protective ownership. Adjacent upland buffer lands also should be sought, in part to protect *viable populations* of pollinator species.

Many of the threats facing the subspecies are aggravated by its small *population* size and limited range-wide distribution; therefore *population augmentation* and initiation of new sub*populations* in suitable unoccupied habitat at Morro Bay should be planned and implemented to reduce the risk of regional extinction. These activities should only occur, however, after a conservation geneticist has assessed the distribution of *genetic* diversity and recommended *population* sampling methods.

Morro Bay *populations* of *Cordylanthus maritimus* ssp. *maritimus* are sensitive to trampling and disturbance and should be protected, by use of fencing, against recreational pressures from nearby residential areas and from park visitors. Access and trails should be routed away from sensitive habitat. Boat haulouts near *populations* of *Cordylanthus maritimus* ssp. *maritimus* must be curtailed. Dredge disposal should be managed to minimize the risk of sand movement burying sub*populations* of the species.

Shoreline stands of *Carpobrotus edulis* (iceplant) should be eradicated and replaced with native *marsh*-upland *ecotone* vegetation. Other *non-native* plants should be controlled to prevent crowding, shading, or other impacts to the salt marsh bird's-beak and its habitat.

Populations of *Cordylanthus maritimus* ssp. *maritimus* should be monitored annually for distribution, abundance, and reproductive output. Continuing and new threats should be identified and reported. Disturbances and sand dune movement should be monitored, and measures to address impacts—as well as to evaluate the success of these measures—should be developed. In addition to monitoring, research is needed--especially on *demography*, ecology, and threats--to ensure that recovery actions effectively benefit the species.

The Service will coordinate with California Department of Parks and Recreation, the City of Morro Bay, and other public or non-profit as well as interested private landowners to achieve comprehensive planning, protection, and recovery benefits for the subspecies. Management plans that address protective and *population augmentation* actions for *Cordylanthus maritimus* ssp. *maritimus* should be developed and implemented for lands in public or conservation ownership.

C. RESTORATION MAPS

To accomplish recovery of the covered species, protection and restoration of the species habitat must occur. The restoration maps in **Figures III-7 through III-32** illustrate only one vision by which recovery may be reached. The figures delineate the highest priority areas for protection of existing habitat, restoration of *tidal marsh*, and restoration of ecotonal habitat. Lands bayward of the recovery unit boundary are lands within the range of historic *tidal marsh*; however, we recognize that not all lands within that boundary will be necessary for recovery of the covered species.

It is important to note that preservation of *diked* wetlands or ponds with muted *tidal* influence may be critical to the survival of some covered species, at least in the short-term. In addition, many sensitive bird species not supported entirely by *tidal marsh* habitat rely on these non- or

muted *tidal* features (*e.g.*, western snowy plover, California least tern, etc). Areas have not been delineated for preservation specifically for these non-covered species, although they may be required to accommodate the complete needs of all species using San Francisco Bay.